Daiwa Capital Markets Hong Kong Limited

Shenzhen Goodix Technology (603160 CH)

Target price: **CNY180.00**

Share price (12 Aug): **CNY170.90** | Up/downside: **+5.3%**

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Outperform (initiation)

Initiation: what's next after fingerprint?

- Leader in the UDFP cycle, looking to pre-empt the competition
- Evolving for the next IoT/3D cycle despite a likely transition
- Initiating coverage with an Outperform (2) rating and TP of CNY180

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Investment case: Founded in 2002, Shenzhen Goodix Technology specialises in biometric authentication, and is strategically transforming its business model into a platform provider to pre-empt the fast-growing under-display fingerprint (UDFP) cycle which could soon face competition. We initiate coverage with an Outperform (2) rating and a 12-month TP of CNY180. Patience may be needed after this year's stock strength, as we envision some margin erosion after its UDFP revenue likely plateaus in 2020, leading to decelerating earnings growth. Yet we expect its expanded footprint into the Internet-of-things (IoT)/3D sensing markets to help bridge the transition and rebuild earnings growth, by capitalising on one of our 4 BigData/IoT themes: the human machine interface (HMI).

Leader in the fast-growing UDFP cycle. In our view, the key to success for a young fabless chipmaker like Goodix is to grow its scale by capturing the right product cycles over time. Jumping from "touch" to fingerprint (FP), Goodix is a leader in the UDFP cycle, experiencing high revenue growth and high margins on an early-cycle advantage. While there are some concerns the cycle is set to peak due to competition, we believe Goodix is pre-empting this risk by transforming from product vendor to platform provider for the next product cycle. It is working on an LCD-version UDFP, which we believe will potentially help prolong and strengthen the UDFP cycle.

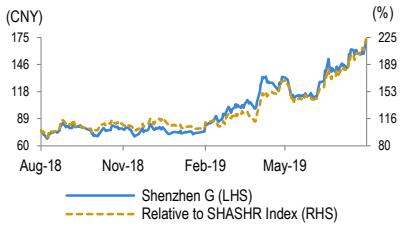
IoT/3D the next driver despite likely transition. With global IT demand evolving into the BigData/IoT cycle, Goodix looks set to capitalise on this secular trend by offering an integrated product platform with 3 key building blocks: data sensing, computing and transmission. Although the business transition may not be smooth, we forecast Goodix's non-FP revenue to expand at a 37% CAGR over 2018-21, reaching 24% of revenue when 3D ramps up to help bridge any gap left by UDFP.

Catalysts: We see 2 catalysts for the share price: 1) the street upgrading its forecasts, as our 2019-20E EPS are 27-32% above the consensus, and 2) Goodix rebuilding its earnings cycle from 2H21 to help catalyse share-price upside. In addition, we see its LCD UDFP as a potential strong catalyst adding to the EPS upside over 2020-21E.

Valuation: We use a 4-quarter forward PER to value Goodix, setting our 12-month TP at CNY180 based on a 37x multiple. Despite our forecast for earnings growth to decelerate after 2019, the LCD UDFP, if successful, could lift EPS growth to 30-35% pa over 2020-21; thus, we see our target PER as undemanding. We initiate coverage with an Outperform (2) rating.

Risks: Key risk: trade tension/the Huawei issue leading to a fall in EPS.

Share price performance



12-month range	67.30-170.90
Market cap (USDbn)	11.07
3m avg daily turnover (USDm)	53.24
Shares outstanding (m)	457
Major shareholder	Zhang Fan (48.1%)

Financial summary (CNY)

Year to 31 Dec	19E	20E	21E
Revenue (m)	6,432	7,722	8,955
Operating profit (m)	2,198	2,423	2,547
Net profit (m)	2,081	2,242	2,361
Core EPS (fully-diluted)	4.556	4.909	5.171
EPS change (%)	180.2	7.8	5.3
Daiwa vs Cons. EPS (%)	31.6	27.4	12.6
PER (x)	37.5	34.8	33.0
Dividend yield (%)	0.3	0.6	0.7
DPS	0.504	1.002	1.232
PBR (x)	13.0	10.0	8.1
EV/EBITDA (x)	34.5	30.2	28.6
ROE (%)	41.2	32.6	27.2

Source: FactSet, Daiwa forecasts

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Outperform
(initiation)

How do we justify our view?

Growth outlook	Valuation	Earnings revisions
✔ ✔	✔ ✔ ✔	✔ ✔ ✔ ✔ ✔

Growth outlook

In our view, Goodix is a well-run but young company in the IC design industry that has seen strong but volatile earnings. It recorded a 61% net-profit CAGR from 2011 to 2018 thanks to the touch and FP cycles. We forecast the company to deliver another strong net-profit CAGR of 47% over 2018-21, due to its lead in the UDFP cycle. Nevertheless, we expect its earnings growth to decelerate after 2019 due to likely increased competition in the UDFP space, before the next uptick in 2H21.

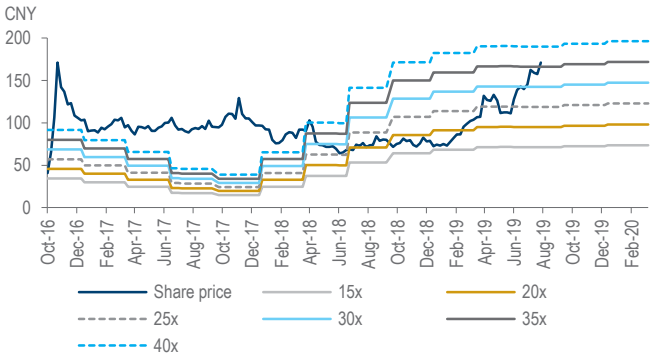
Goodix: net-profit trend

Source: Company, Daiwa forecasts

Valuation

Given its short trading history and inflated valuation in 2017 post its IPO on likely inflated market sentiment, Goodix's share-price performance record may not be a meaningful indicator of its future performance. Yet, the stock looks to have been rerated to above 30x 4-quarter forward PER, off its trough of 16x in January 2019. From a PEG perspective, we see a 37x PER as a fair target PER for the stock, given its normalised EPS growth of 20-40% over a 3-5 year timeframe on our forecasts, regardless of its earnings-growth volatility on an annual basis. Therefore, we set our 12-month TP at CNY180.

Goodix: 4-quarter forward PER bands

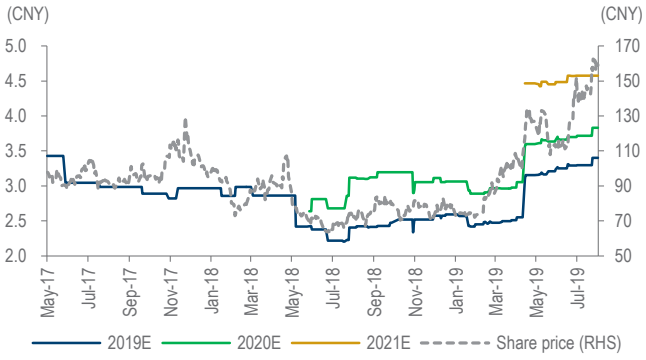


Source: Company, Bloomberg, Daiwa estimates & forecasts

Earnings revisions

The street's forecasts for Goodix's earnings have trended up after bottoming during 2H18 per Bloomberg, which has helped boost the stock's performance, in our opinion. Our 2019-20 EPS forecasts are still 27-32% above the consensus numbers, and we expect further share upside in the near term as we expect the street to lift its forecasts, helping enhance market sentiment towards the stock. Our higher forecasts are premised on our more positive share assumption for Goodix in the UDFP market, as well as its active penetration into the IoT markets.

Goodix: consensus EPS forecast revisions



Source: Bloomberg

Financial summary

Key assumptions

Year to 31 Dec	2014	2015	2016	2017	2018	2019E	2020E	2021E
Touch controller shipments (m)	0	237	269	259	247	271	284	298
Touch controller ASP (USD)	0.00	0.57	0.50	0.53	0.50	0.54	0.55	0.55
Fingerprint sensor shipments (m)	0	11	166	229	230	352	438	511
Fingerprint sensor ASP (USD)	0.00	3.63	1.97	1.78	1.88	2.25	2.16	1.94
3D laser sensor shipments (m)	0	0	0	0	0	0	3	25
3D laser sensor ASP (USD)	0.00	0.00	0.00	0.00	0.00	0.00	7.40	5.82

Profit and loss (CNYm)

Year to 31 Dec	2014	2015	2016	2017	2018	2019E	2020E	2021E
Touch controller IC	0	0	898	927	823	998	1,075	1,128
Fingerprint sensor IC	0	0	2,176	2,749	2,893	5,429	6,507	6,808
Other Revenue	854	1,120	5	5	5	5	140	1,019
Total Revenue	**854**	**1,120**	**3,079**	**3,682**	**3,721**	**6,432**	**7,722**	**8,955**
Other income	0	0	0	0	0	0	0	0
COGS	(294)	(472)	(1,628)	(1,947)	(1,779)	(2,494)	(3,343)	(4,210)
SG&A	(140)	(251)	(205)	(283)	(409)	(564)	(607)	(676)
Other op.expenses	(10)	(11)	(333)	(629)	(877)	(1,176)	(1,349)	(1,522)
Operating profit	**409**	**386**	**914**	**823**	**656**	**2,198**	**2,423**	**2,547**
Net-interest inc./(exp.)	6	14	(5)	14	1	5	28	27
Assoc/forex/extraord./others	30	36	78	124	89	113	40	50
Pre-tax profit	**445**	**436**	**987**	**961**	**746**	**2,315**	**2,491**	**2,624**
Tax	(61)	(58)	(130)	(74)	(4)	(235)	(249)	(262)
Min. int./pref. div./others	0	0	0	(0)	0	0	0	0
Net profit (reported)	**384**	**378**	**857**	**887**	**742**	**2,081**	**2,242**	**2,361**
Net profit (adjusted)	**384**	**378**	**857**	**887**	**742**	**2,081**	**2,242**	**2,361**
EPS (reported)(CNY)	**2.325**	**0.946**	**1.925**	**1.953**	**1.626**	**4.556**	**4.909**	**5.171**
EPS (adjusted)(CNY)	**2.325**	**0.946**	**1.925**	**1.953**	**1.626**	**4.556**	**4.909**	**5.171**
EPS (adjusted fully-diluted)(CNY)	**2.325**	**0.946**	**1.925**	**1.953**	**1.626**	**4.556**	**4.909**	**5.171**
DPS (CNY)	**0.500**	**0.248**	**0.225**	**0.392**	**0.606**	**0.504**	**1.002**	**1.232**
EBIT	**409**	**386**	**914**	**823**	**656**	**2,198**	**2,423**	**2,547**
EBITDA	**417**	**398**	**933**	**846**	**689**	**2,248**	**2,490**	**2,631**

Cash flow (CNYm)

Year to 31 Dec	2014	2015	2016	2017	2018	2019E	2020E	2021E
Profit before tax	445	436	987	961	746	2,315	2,491	2,624
Depreciation and amortisation	7	12	19	23	33	50	67	84
Tax paid	(61)	(58)	(130)	(74)	(4)	(235)	(249)	(262)
Change in working capital	(57)	(169)	(1,081)	43	369	(1,670)	890	(1,560)
Other operational CF items	1	7	23	146	88	0	0	(0)
Cash flow from operations	**335**	**228**	**(182)**	**1,100**	**1,232**	**460**	**3,199**	**886**
Capex	(73)	(34)	(28)	(71)	(363)	(322)	(386)	(448)
Net (acquisitions)/disposals	0	(14)	(1)	(1,150)	(1,285)	0	0	0
Other investing CF items	0	19	8	5	(63)	0	0	0
Cash flow from investing	**(73)**	**(29)**	**(21)**	**(1,216)**	**(1,711)**	**(322)**	**(386)**	**(448)**
Change in debt	0	0	0	0	(1)	0	0	0
Net share issues/(repurchases)	0	0	810	444	132	0	0	0
Dividends paid	(83)	(99)	(100)	(178)	(277)	(230)	(458)	(563)
Other financing CF items	(1)	(3)	(18)	(3)	(40)	0	0	0
Cash flow from financing	**(83)**	**(102)**	**692**	**263**	**(185)**	**(230)**	**(458)**	**(563)**
Forex effect/others	1	10	9	(9)	7	0	0	0
Change in cash	**179**	**108**	**497**	**137**	**(657)**	**(91)**	**2,355**	**(125)**
Free cash flow	262	194	(210)	1,028	870	139	2,813	438

Source: FactSet, Daiwa forecasts

Financial summary continued …

Balance sheet (CNYm)

Year to 31 Dec	2014	2015	2016	2017	2018	2019E	2020E	2021E
Cash & short-term investment	498	606	1,104	1,241	583	492	2,847	2,722
Inventory	104	142	550	526	403	823	823	1,243
Accounts receivable	184	341	1,213	1,097	1,040	2,460	1,690	2,990
Other current assets	5	26	57	1,195	2,524	2,500	2,500	2,500
Total current assets	**791**	**1,114**	**2,923**	**4,058**	**4,551**	**6,275**	**7,860**	**9,455**
Fixed assets	146	161	178	234	576	874	1,226	1,632
Goodwill & intangibles	4	53	52	65	160	150	150	150
Other non-current assets	65	64	62	60	58	58	58	58
Total assets	**1,005**	**1,393**	**3,215**	**4,418**	**5,345**	**7,357**	**9,295**	**11,296**
Short-term debt	0	0	0	0	0	0	0	0
Accounts payable	72	113	305	280	322	492	612	772
Other current liabilities	40	101	160	632	886	850	875	910
Total current liabilities	**112**	**213**	**465**	**912**	**1,208**	**1,342**	**1,487**	**1,682**
Long-term debt	0	0	0	0	0	0	0	0
Other non-current liabilities	1	6	14	20	30	33	35	35
Total liabilities	**113**	**219**	**479**	**932**	**1,238**	**1,375**	**1,522**	**1,717**
Share capital	165	400	445	454	457	457	457	457
Reserves/R.E./others	727	772	2,290	3,032	3,651	5,526	7,316	9,122
Shareholders' equity	**892**	**1,172**	**2,735**	**3,486**	**4,107**	**5,982**	**7,773**	**9,579**
Minority interests	0	2	2	0	0	0	0	0
Total equity & liabilities	**1,005**	**1,393**	**3,215**	**4,418**	**5,345**	**7,357**	**9,295**	**11,296**
EV	77,544	77,438	76,940	76,801	77,458	77,550	75,195	75,320
Net debt/(cash)	**(498)**	**(606)**	**(1,104)**	**(1,241)**	**(583)**	**(492)**	**(2,847)**	**(2,722)**
BVPS (CNY)	**5.409**	**2.930**	**6.145**	**7.674**	**8.995**	**13.101**	**17.022**	**20.976**

Key ratios (%)

Year to 31 Dec	2014	2015	2016	2017	2018	2019E	2020E	2021E
Sales (YoY)	24.5	31.1	175.0	19.6	1.1	72.8	20.0	16.0
EBITDA (YoY)	27.5	(4.5)	134.5	(9.3)	(18.6)	226.3	10.8	5.7
Operating profit (YoY)	26.3	(5.8)	137.1	(10.0)	(20.3)	235.2	10.2	5.1
Net profit (YoY)	49.5	(1.4)	126.5	3.5	(16.3)	180.2	7.8	5.3
Core EPS (fully-diluted) (YoY)	49.5	(59.3)	103.6	1.4	(16.7)	180.2	7.8	5.3
Gross-profit margin	65.5	57.9	47.1	47.1	52.2	61.2	56.7	53.0
EBITDA margin	48.8	35.5	30.3	23.0	18.5	34.9	32.2	29.4
Operating-profit margin	48.0	34.4	29.7	22.4	17.6	34.2	31.4	28.4
Net profit margin	44.9	33.8	27.8	24.1	20.0	32.3	29.0	26.4
ROAE	51.7	36.7	43.9	28.5	19.6	41.2	32.6	27.2
ROAA	46.4	31.6	37.2	23.2	15.2	32.8	26.9	22.9
ROCE	55.2	37.3	46.8	26.5	17.3	43.6	35.2	29.4
ROIC	105.8	69.5	72.1	39.2	22.6	43.8	41.9	38.9
Net debt to equity	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Effective tax rate	13.7	13.2	13.2	7.7	0.5	10.1	10.0	10.0
Accounts receivable (days)	63.8	85.5	92.1	114.5	104.8	99.3	98.1	95.4
Current ratio (x)	7.1	5.2	6.3	4.5	3.8	4.7	5.3	5.6
Net interest cover (x)	n.a.	n.a.	167.1	n.a.	n.a.	n.a.	n.a.	n.a.
Net dividend payout	32.1	25.8	26.4	20.8	31.2	31.0	22.0	25.1
Free cash flow yield	0.3	0.2	n.a.	1.3	1.1	0.2	3.6	0.6

Source: FactSet, Daiwa forecasts

Company profile

Founded in 2002, Goodix started its business with telephone communication ICs. Goodix tapped into the smartphone market in 2011 when MediaTek (MTK) invested in it and helped it with the inclusion of its touch controller ICs in MTK's reference design. In 2015, Goodix expanded its product reach to fingerprint (FP) capacitive ICs for biometric authentication. FP ICs contribute the majority of its revenue, with the rest from touch controllers and others where it aims to expand its addressable markets by diversifying into the IoT markets.

Initiation: what's next after fingerprint?

Founded in 2002 by Mr. Fan Zhang, the president and CEO, with around a 48% stake, Goodix was the largest listed integrated circuit (IC) designer in China by revenue in 2018. It specialises in biometric authentication, and is a market leader in the fast-growing under-display fingerprint (UDFP) cycle after expanding its business through the touch and capacitive FP product cycles. Although there are some concerns that Goodix may soon pass the sweet spot with its early-cycle advantage in the UDFP cycle, it is strategically transforming its business model into a platform provider to pre-empt any product-transition risk. This transformation meets one of our investment themes under the BigData/IoT cycle – namely human-machine interface (HMI). We see Goodix as ready to capitalise on this secular theme by offering its integrated platforms with 3 key building blocks: data sensing, computing and transmission.

We initiate coverage of the stock with an Outperform (2) rating and a 12-month TP of CNY180. Patience may be needed as we expect some margin erosion after Goodix's UDFP revenue plateaus in 2020, which would likely lead to a deceleration in earnings growth. Yet, we expect the company's expanded footprint in the IoT market – with 3D laser sensing likely the next growth driver – to help bridge the transitional gap and rebuild earnings growth. Its newly developed LCD UDFP should potentially help prolong and strengthen the UDFP cycle, in our view. Any share-price weakness after an increase in consensus forecasts would be a further opportunity to accumulate, in our view.

Leader in the fast-growing UDFP cycle

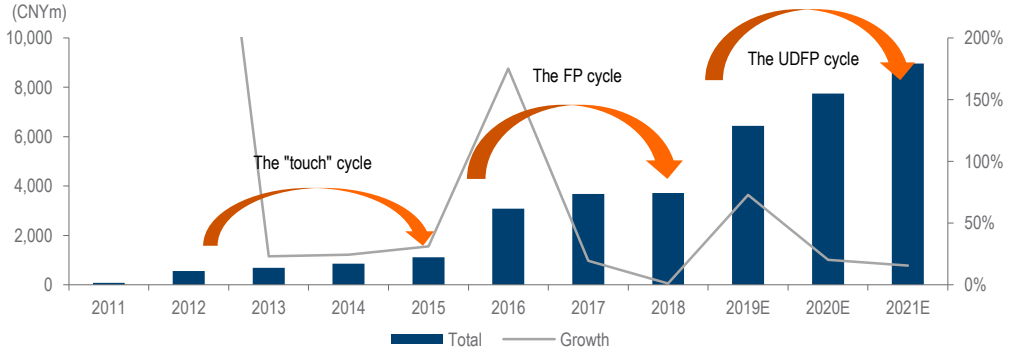
We see "cycle+scale" as a recipe for success for a fabless chipmaker

In our view, fabless chipmakers in the global IC design industry are "cycle plays", as they ride on demand cycles by capturing the right products in the right cycle at the right time, to enjoy early-cycle advantages such as good margins before the competition catches up. While this is a recipe for success for a relatively young fabless chipmaker like Goodix, with revenue currently below the USD1bn mark, to expand through multiple product cycles, scale matters when the aim is to ride on several demand cycles in order to diversify business risk. This combination of "cycle plus scale" has made global giants such as Broadcom, Qualcomm, Nvidia, MediaTek (MTK; 2454 TT, TWD323, Buy [1]) and AMD stand out over time, enjoying revenue of several billion US dollars a year (see our company profile on page 28 for more on the global IC design industry).

Goodix first ramped up its revenue during the "touch cycle"…

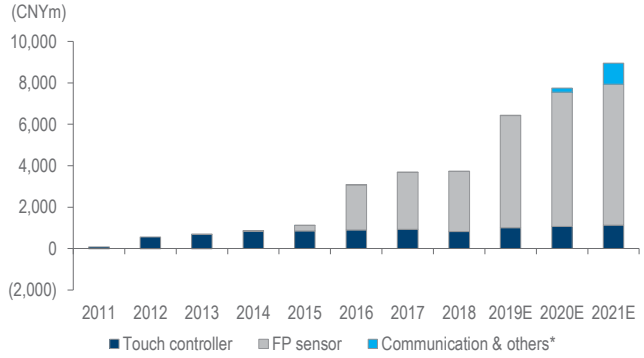
Since its establishment in 2002, Goodix has captured 3 product cycles in the mobile-device markets (such as smartphones and tablets), with each cycle lasting around 3-4 years depending on the product life and competition. The first product cycle that helped ramp up its revenue scale to the USD100m mark was the "touch cycle" during 2012-15, where Goodix offered capacitive-type touch controller ICs to penetrate the smartphone market for touch-display solutions. We believe MTK's investment in Goodix in 2011 helped Goodix leverage on MTK's reference-design platform in China's smartphone industry and build itself a solid customer base comprised of China's leading smartphone vendors.

Goodix: revenue build through 3 key product cycles



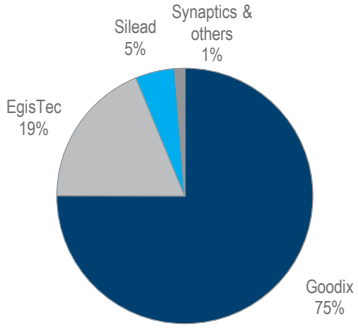
Source: Company, Daiwa estimates & forecasts

Goodix: revenue breakdown by product



Source: Company, Daiwa estimates & forecasts
*Note: * Others including new products such as 3D laser sensing*

UDFP market share forecast* (2019E)



Source: Company, Daiwa forecasts
*Note: * Optical type only for Android platform*

… it then jumped to the FP cycle after touch, tripling its revenue in 3 years

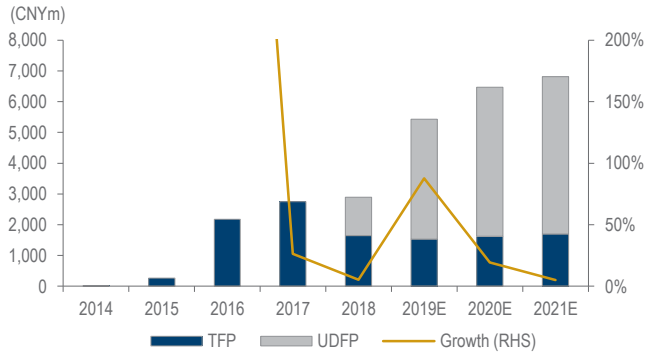
After touch cycle growth tapered off, Goodix entered the next product cycle, fingerprint (FP) authentication, in 2014 by offering capacitive-type FP sensors to mobile-device vendors, riding on smartphone demand. FP-enabled smartphones took off over 2013-17, essentially doubling shipment volumes each year on average, thanks to Apple's push, followed by Android vendors' adoption of FP sensors (see FP market analysis on pages 24-27 for details). Although the transition between product cycles in the IC design industry is typically not smooth in terms of timing, especially for a latecomer like Goodix, it nevertheless entered the FP market in 2014 and tripled its scale over 2016-18 through share gains from market leaders such as FPC and Synaptics during this cycle. Its total revenue surpassed the USD500m mark in 2017 before competition heated up from the likes of EgisTec and Silead in the Android smartphone space. Goodix's FP revenue contribution ramped up to over 70% during the cycle from just 1% in 2014.

With demand for capacitive FP likely to decline in 2019 as a result of smartphone vendors shifting to full-screen displays with organic light emitting diode (OLED) technology to sustain consumer traction and extend the smartphone life cycle, UDFP technology is on the rise to replace traditional capacitive type FP (TFP). Unlike TFP, which places the FP sensor on the surface of the display, UDFP embeds the sensor below the display without impacting the aesthetics of a full-screen phone. This approach requires fundamental changes in technology, including a change in sensors from capacitive-type to optical or ultrasonic, as well as software algorithms to make the efficiency of FP authentication comparable to that of TFP (see Appendix 1 on page 31 for more on FP technologies).

Goodix is a leader in the UDFP cycle, with the lion's share of the market in 1H19

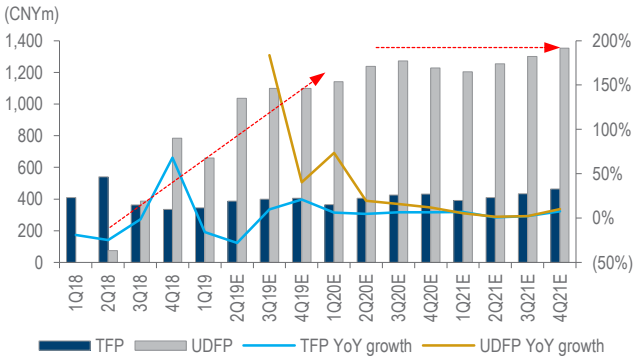
After years of building up its tech know-how, Goodix is taking the driver's seat as a leader in the UDFP cycle in terms of time-to-market and scale-ramp, in our view, and therefore benefits from early-cycle advantages. Goodix began shipping its UDFP solutions in June 2018, ramping up its product sales to CNY780m in 4Q18 from CNY388m in 3Q18 for a total revenue contribution of 58% (see page 14 on Daiwa's key business assumptions for details). We estimate it had a c.90% share of the optical UDFP market in 1H19. We forecast Goodix to ship 120m UDFP module units for revenue of CNY3.9bn in 2019, tripling its revenue YoY for a global market share of c.75% (by shipment, optical type only for the Android platform since Goodix adopts the optical solution, excluding the ultrasonic type promoted by the likes of Qualcomm).

Goodix: FP revenue trend



Source: Company, Daiwa estimates & forecasts

Goodix: FP revenue ramp (UDFP vs. TFP)



Source: Company, Daiwa forecasts

UDFP cycle in the early stages, yet competition may heat up soon

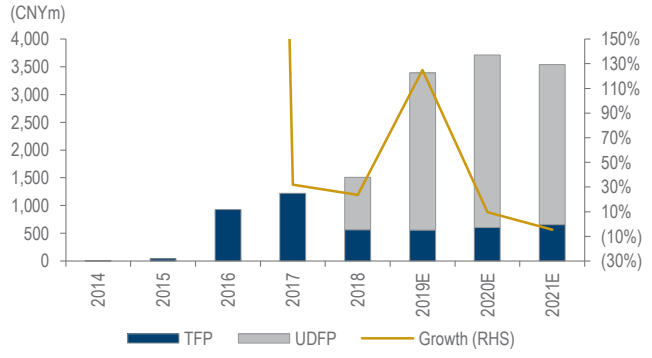
Unlike TFP, Goodix sells its UDFP solutions in module form, which includes the optical sensor chip, integrated micro-controller unit (MCU) with algorithms, as well as optical lens, thus making it ASP accretive. We estimate the ASP for its UDFP solutions was c.5x that of TFP in 1H19. Thanks to Goodix's early-cycle advantages, its UDFP solutions are margin-accretive, enabling Goodix to realise a gross margin of more than 70% in 1H19, on our estimates. According to our market analysis (see FP market analysis for details), the UDFP market looks to be in its early stages, with 45% penetration of the Android OLED smartphone market in 2019 (10% in 2018), rising to 75% in 2020 and 88% in 2021, on our forecasts, before plateauing in 2022. However, competition appears to have increased quickly from the likes of Silead and EgisTec, which could impact Goodix's ASP and gross margin.

Goodix appears to be pre-empting the competition, though the transition may take time

On a quarterly basis, we forecast Goodix's UDFP revenue to plateau in 2H20 at around CNY1.2bn/quarter as a result of price competition despite continued expansion in shipments. Management anticipates 20-30% price erosion in 2019, which we think is reasonable; we model average price erosion of 5% QoQ over 2019-20E. As such, Goodix's UDFP gross profit will likely contract in 2021, after growing strongly in 2019 to CNY2.8bn and CNY3.1bn in 2020 despite revenue expansion, with its gross margin falling to below 60% by end-2021, on our forecasts.

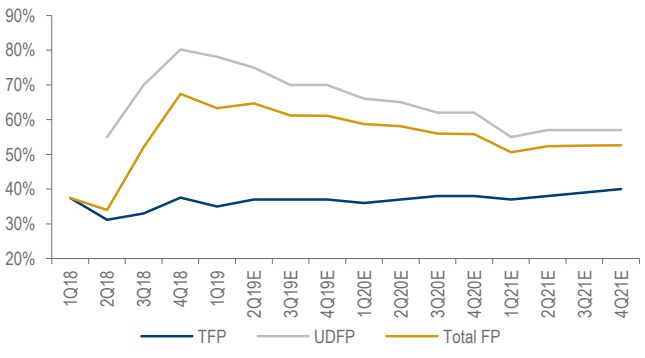
The possibility of this unfavourable trend as a result of competition extending beyond 2019 would likely raise market concerns that the best part (sweet spot) of the UDFP cycle for Goodix would soon end. We do not share this concern, as we believe Goodix is making a pre-emptive move to expand its footprint into the next secular demand cycles of IoT and 3D laser sensing. This meets our investment thesis on human-machine interface (HMI) and echoes the "only the paranoid survive" statement of Dr. Andrew Grove, one of the founders and chairman of Intel. In this respect, we like Goodix's efforts at being "paranoid", though any transition between product cycles in the IC design space may not be smooth. In addition, we see the development of LCD-version UDFP as potentially helping prolong, amplify and strengthen the UDFP cycle.

Goodix: FP gross-profit trend



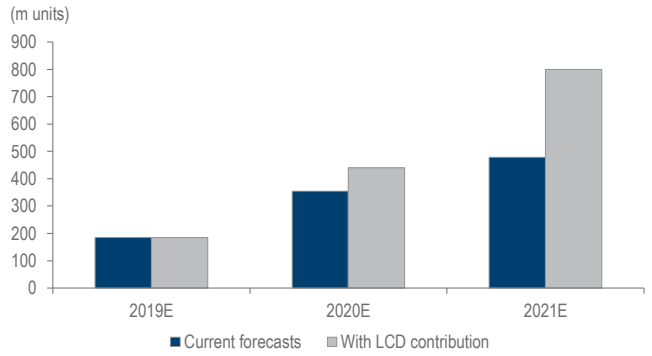
Source: Company, Daiwa estimates & forecasts

Goodix: FP gross-margin breakdown by UDFP vs. TFP



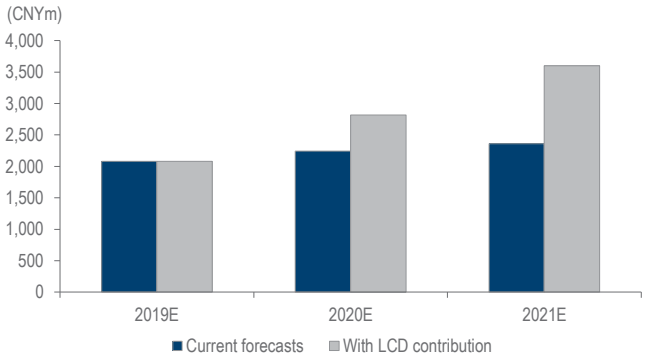
Source: Company, Daiwa forecasts

Upside potential for UDFP market with LCD version



Source: Daiwa estimates & forecasts

Upside potential for Goodix's net profit from LCD version



Source: Daiwa forecasts

Potential earnings upside from LCD-version UDFP

In our view, LCD-version UDFP technology is likely to increase Goodix's net profit by 25-50% over 2020-21E

Per our discussion in the FP market analysis section, existing UDFP technologies focus on OLED smartphones due to technological issues with their implementation in LCD models, where the use of backlight sources affects the efficiency of FP authentication. Goodix is working on an LCD-version UDFP to address these issues, and aims to sample its solutions with customers in 3Q19 for possible commercialisation in 2020, depending on market demand, execution of technology, and price/performance considerations. LCD smartphone shipment volumes in the Android space were 2.6x OLED volumes in 2018, and we expect the gap to be 2.3-1.5x over 2019-21E, despite OLED's rising penetration, which should present meaningful upside potential in terms of UDFP penetration in smartphones. We forecast shipments of nearly 800m LCD smartphones in 2021 for the Android market.

We have not factored in the potential earnings upside for Goodix from LCD UDFP into our forecasts due to the lack of a track record in commercialisation. However, should the LCD-version UDFP succeed, we believe it would help prolong the UDFP product cycle and amplify its revenue scale. Therefore, our sensitivity analysis assumes Goodix can commercialise this solution following the similar ramping trajectory of the OLED version, with the total UDFP market potentially reaching 440m units in 2020E and 800m units in 2021E — respectively 24% and 67% above our current forecasts without the LCD contribution — and potentially increasing Goodix's net profit by 25% in 2020E and 50% in 2021E. In this case, we estimate the stock would have a fair value of CNY255, applying a 37x PER to our average 2020-21E EPS.

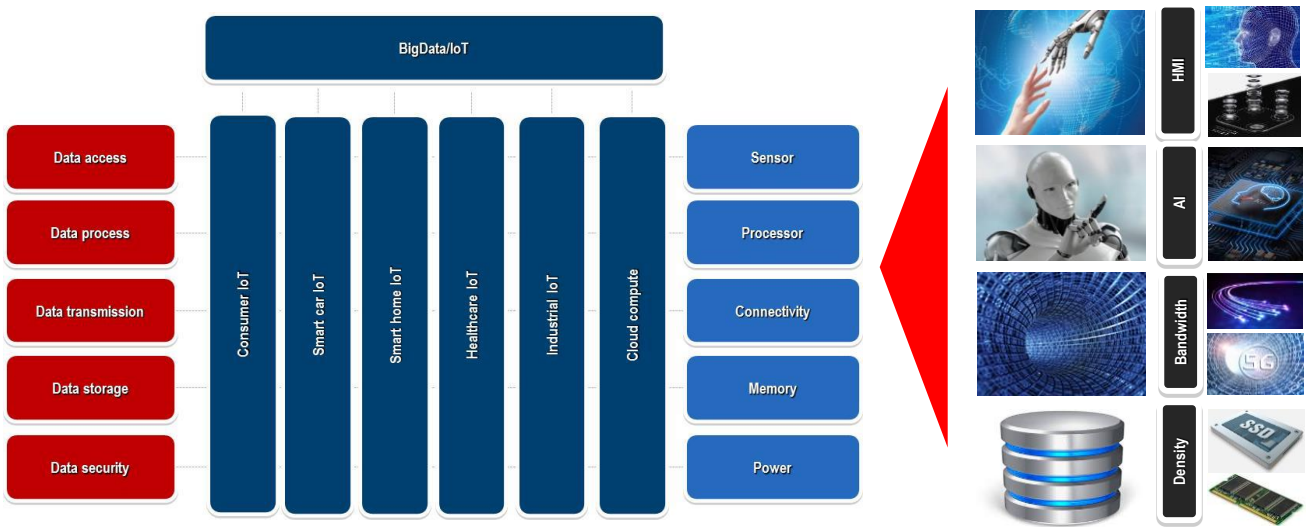
IoT/3D the next driver despite likely transition

We believe Goodix is ready to capitalise on the next BigData/IoT cycle ahead of the UDFP cycle

Goodix has been enriching its product portfolio since the tapering-off of the capacitive touch and FP cycles, and preparing for the coming BigData/IoT demand cycle. Recall that in our BigData thematic report (*Big Data: the next big thing*, 2 January 2015), we defined the next mega-cycle of BigData/IoT in the global IT market as shown in the chart next page. In the context of Goodix, the company prioritises the consumer and smart-home IoT as its target markets for product diversification and business expansion, in addition to a piece of the smart-car IoT market for additional revenue (ie, automotive infotainment systems).

In our 2019 Tech Outlook, *A year of new leadership*, published on 7 January, we argued that 4 secular trends of HMI, artificial intelligence (AI), bandwidth and density would lead to 6 themes for structural investments, in terms of technology: multiple cameras (multi-cam), 3D laser sensing, high-performance computing (HPC), fibre-optic (FO) data transmission, 5G cellular migration and memory including NAND and DRAM. The key focus for Goodix's business expansion beyond the UDFP cycle, as evidenced by its business transformation strategy highlighted recently by its president & CEO Mr. Zhang, is HMI technologies, with a variety of sensors handling data access across IoT applications in the consumer, smart-home, and smart-car segments.

Rising structural trends of bandwidth, HMI, AI and density under the BigData/IoT demand cycle



Source: Daiwa

Thanks to advances in its core competencies over the years, Goodix can offer a comprehensive suite of sensors, including touch sensors, TFP which uses capacitive sensors, UDFP which uses optical CMOS image sensors (CIS), as well as 3D sensors that use vertical cavity surface emitting laser (VCSEL) chips for sensing and imaging. We believe Goodix stands prepared to capitalise on the HMI theme under our definition of the BigData/IoT cycle for structural business growth.

IoT

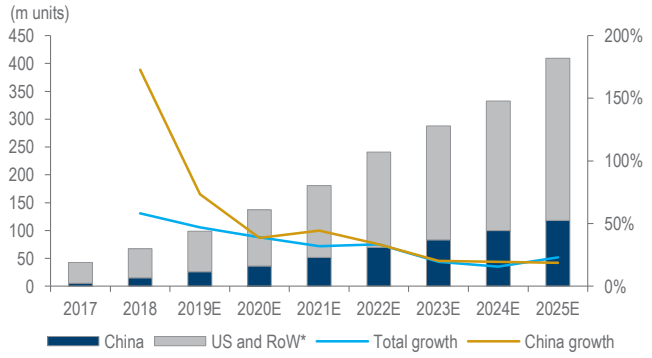
Customised product-platform solutions centring on data sensing, computing and transmission for the IoT market

As depicted on the chart next page, the global smart-speaker market is expected to expand at a 39% CAGR over 2018-21 in terms of shipments, according to Loupventures, where China should lead the pack in terms of growth with a 51% CAGR for a 25-30% share of the market. Smart speakers are only a fraction of the IoT demand cycle, in our opinion. Goodix began penetrating the smart speaker and automotive infotainment system segments in 2017 with its capacitive touch and FP products, with the goal of transforming its business model by offering a platform with comprehensive product portfolios to capitalise on rising demand for consumer, smart-home, and smart-car IoT devices.

According to Mr. Zhang at the company's 1Q19 results conference, Goodix aims to offer a product platform integrating sensors, MCU and connectivity chips such as Bluetooth low-energy (BLE) covering short range and narrow-band IoT (NB-IoT) for longer-range data transmissions to broaden its addressable markets for customised on-demand services. We are positive on this platform strategy, which appears to be a trend the industry leaders such as MTK, Qualcomm, Xilinx and Nvidia are following under the BigData/IoT cycle, albeit with different scales of vertical demand coverage.

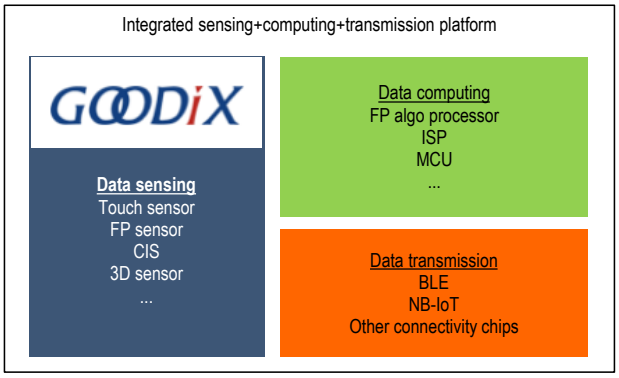
Goodix acquired the Germany-based intellectual property (IP) firm Commsolid in November 2018 via its 100%-owned subsidiary Goodix Technology (HK) (匯頂科技［香港］) for EUR10.6m to enrich its connectivity portfolio with Commsolid's NB-IoT IP. The chart next page illustrates how Goodix integrates these building blocks to offer its customers tailor-made product platforms centring on its 3 core technology competencies of data sensing, data computing, and data transmission.

Global smart-speaker demand forecasts



Source: Loupventures
*Note: * RoW = rest of the world*

Goodix's integrated building blocks for IoT*



Source: Company, Daiwa
*Note: * ISP=image signal processor, CIS=CMOS image sensor, BLE=blue-tooth low-energy*

Apart from supplying products to global leading smart-speaker vendors, we believe Goodix is cooperating with Xiaomi under the latter's MiJia (米家) smart-home platform to expand addressable markets in China by working with Xiaomi's module suppliers on smart locks and smart meters.

IoT likely to revive Goodix's non-FP revenue, which we forecast to rise at a CAGR of 37% over 2018-21

Despite fragmented contributions, we forecast Goodix's IoT penetration to contribute incremental revenue of CNY175m, CNY200m-plus and CNY900m-plus for 2019, 2020 and 2021, respectively, across the multiple product offerings under its platform strategy. Therefore, despite it reaching maturity in the smartphone space, we forecast Goodix's non-smartphone business, including touch sensors, TFP sensors and communication ICs, to expand once again after being recycled for new applications with enriched features for customisation. On our forecasts, this will lead to its total non-FP revenue, including 3D sensing, exceeding CNY2bn in 2021 for a 24% revenue contribution, translating into a CAGR of 37% over 2018-21 (see charts next page).

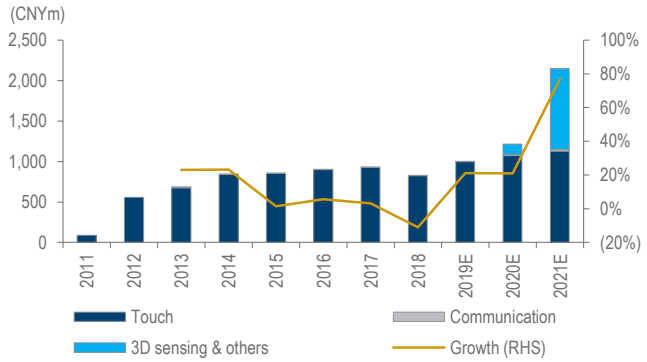
Example of smart speakers with Goodix solutions

Source: Company, Daiwa

Example of smart-home platform with Goodix solutions

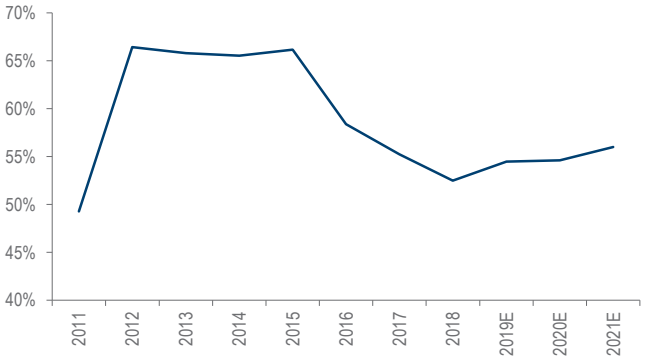
Source: Company, Daiwa

Goodix: non-FP revenue trend*



Source: Company, Daiwa estimates & forecasts
*Note: * Others include any other customized IoT applications*

Goodix: non-FP gross margin forecasts*



Source: Daiwa estimates & forecasts
*Note: * Non-FP includes communication, touch, 3D sensing & other new IoT solutions*

3D

We expect 3D laser sensors to be a significant IoT revenue contributor from 2021E …

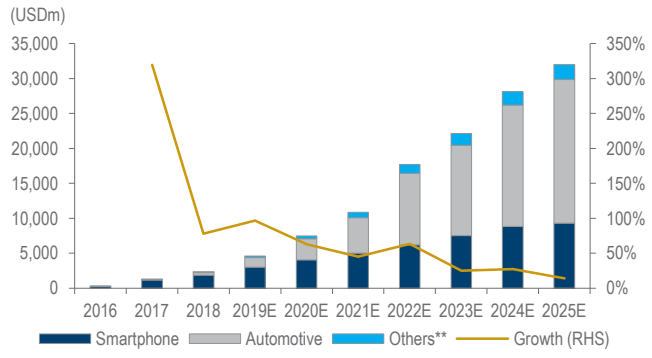
As part of Goodix's non-FP business portfolio, we expect 3D laser sensors to contribute most of the company's revenue growth starting from 2021 when the technology matures and opens up to mass markets leading to economies of scale, against the backdrop of yield improvements industry-wide to enhance price/performance profile, as well as a new ecosystem build from Android platform for new applications of augmented reality (AR) and mixed reality (MR).

Recall that in our 3D laser thematic report published in June 2017, *Asian Optical Sensing & Communication: A whole new world*, we wrote that we expected the implementation of low-power lasers (or consumer lasers) for illumination, sensing and imaging of objects to become a disruptive technology in the HMI space as it changes the way humans interact with machines, from 2D to 3D. We expected this to lead to significant demand for 3D laser sensors in the coming years thanks to broad applications from consumer, automotive, industrial, medical and the military.

… on the prospect of strong 3D VCSEL demand growth

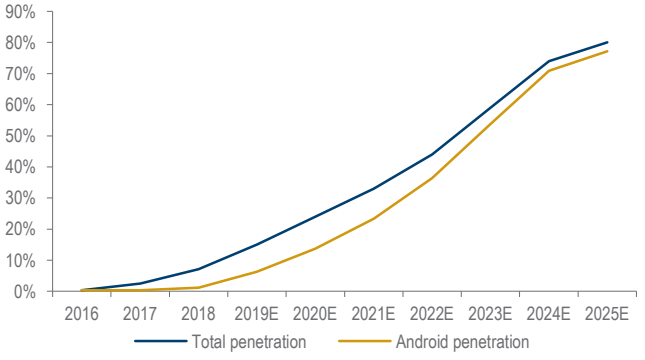
We forecast the global consumer laser market, led by VCSEL in terms of light-emitting technology, to roughly double in size in 2019 to USD4.6bn at the module level and expand by 63% YoY for 2020, reaching USD11bn in 2021, for a CAGR of 67% over 2018-21E. Demand strength is likely to be driven by smartphones at first and followed by automotive devices including light detection and ranging (LiDAR) and laser headlights, as well as AI surveillance and industrial robotics. Despite not being on the first-wave supplier-list which includes the likes of Lumentum, ams, II-VI and Osram, Goodix stands to benefit, in our view, as the 3D VCSEL market is still young and it should be able to accommodate multiple players for multiple years as a result of its growing status and decent market size.

Global consumer laser demand forecasts*



Source: Daiwa estimates & forecasts
*Note: * Valued at module level; ** Others include surveillance, gaming, IIoT, etc*

3D laser sensor penetration in smartphones*



Source: Daiwa estimates & forecasts
*Note: * Using depth cameras as a proxy, either front-facing or world-facing, SL or ToF*

Like UDFP, Goodix aims to offer integrated module solutions for 3D sensors

We understand that Goodix began designing and developing its own VCSEL-based 3D sensing solutions in 2017, focusing on structural-light (SL) architecture, with the goal of going into mass production in 2H19. By designing key chips and asking its foundry partners to manufacture the chips, Goodix plans to offer customers a total solution that includes:

- VCSEL light transmitters (Tx)
- CIS light receivers (Rx)
- Image signal processors (ISP) for algorithms used in sensing and imaging computation
- Diffractive optical elements (DOE) for light filtering
- MCUs for process control
- Leaving only the procurement of the lens sets from third-party suppliers

Although commercialisation of 3D lasers is likely to be delayed …

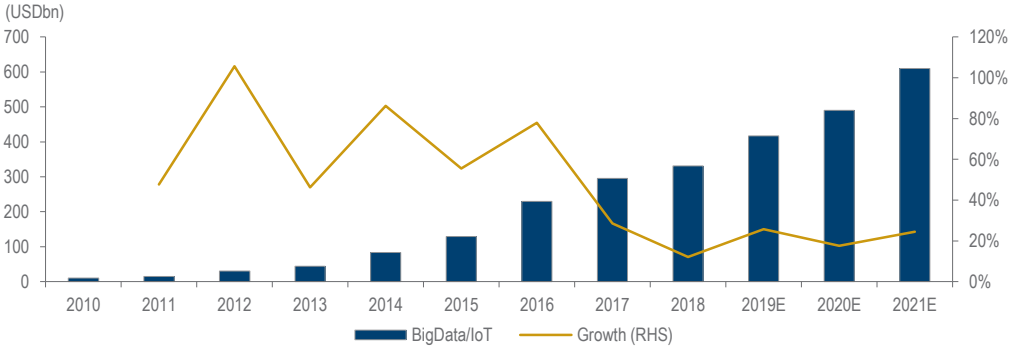
Although commercialisation of 3D laser solutions appears to be behind schedule due to limited interest from Android smartphone vendors in China in 2019, per management, we believe this is a structural demand trend which Goodix will not ignore. Indeed, we understand that, in addition to the SL solutions for front-facing, the company is working on another type of time-of-flight (ToF) solution aimed at riding on the world-facing trend for AR/MR applications once the ecosystem is built out on the Android platform likely in 2021. Goodix does not view 3D sensing as a substitute technology for UDFP due to the different application focus, which is in line with our view.

… we expect a meaningful ramp-up in 2021 when the ecosystem is built

We expect 3D VCSEL demand to ramp up meaningfully starting from 2020 when costs fall on yield improvements and thus gain traction from Android smartphone vendors for their mid-range models. We expect Goodix to begin to see a meaningful revenue contribution from 3D sensing in 2021. We forecast its 3D sensing revenue to approach CNY1bn (up 6x YoY) in 2021 for a 10% revenue contribution, which is not demanding, in our opinion, since this would translate into only a single-digit percentage share for Goodix in the 3D-enabled Android smartphone market.

We forecast Goodix's total non-FP revenue to expand at a 37% CAGR over 2018-21 to exceed CNY2bn (USD310m) in 2021 for 24% of total revenue. Per our 2019 Tech Outlook, we forecast global IoT market revenue to expand at a 25% CAGR over 2018-21, overtaking the mobile computing device (MCD) market in 2019 to mark a milestone in the global tech sector, with demand strength driven particularly by the consumer, smart-home and smart-car IoT segments, which should ramp up faster than other demand verticals. Using this forecast as a cross-check for Goodix from a macro perspective, we are comfortable with our forecasts for its IoT-related business ramp-up trajectory.

Global IoT market forecasts*



Source: Daiwa estimates & forecasts
*Note: * IoT including wearables, smart home like TV and appliances, smart car, IIoT and all other IoT devices with innovation*

Goodix: key assumptions for Daiwa's earnings model

	1Q19	2Q19E	3Q19E	4Q19E	1Q20E	2Q20E	3Q20E	4Q20E	1Q21E	2Q21E	3Q21E	4Q21E
Product shipment (000)												
Touch controller	65,000	68,000	70,000	68,000	65,000	70,000	74,000	75,000	70,000	74,000	77,000	77,000
FP sensor/module*	70,700	89,000	95,000	97,500	98,500	107,000	115,000	117,000	116,000	123,000	131,000	140,500
TFP	51,000	58,000	61,000	62,000	59,000	62,000	65,000	66,000	63,000	66,000	70,000	75,000
UDFP	19,700	31,000	34,000	35,500	39,500	45,000	50,000	51,000	53,000	57,000	61,000	65,500
Communication IC	1,000	1,000	1,000	1,000	1,000	1,500	1,800	2,000	1,800	2,200	2,500	2,600
3D sensing module	0	0	0	0	0	0	1,000	1,500	3,000	5,000	8,000	9,000
ASP (USD)												
Touch controller	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
FP sensor/module	2.1	2.3	2.3	2.2	2.2	2.2	2.1	2.1	2.0	2.0	1.9	1.9
TFP	1.0	1.0	1.0	1.0	0.9	1.0	1.0	1.0	0.9	0.9	0.9	0.9
UDFP	5.0	4.9	4.7	4.5	4.2	4.0	3.7	3.5	3.3	3.2	3.1	3.0
Communication IC	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3
3D sensing module	0.0	0.0	0.0	0.0	10.0	9.0	8.0	7.0	6.6	6.1	5.7	5.5
Revenue (USD000)												
Touch controller	32,728	37,400	38,500	37,400	35,750	38,500	40,700	41,250	38,500	40,700	42,350	42,350
FP sensor/module	148,515	208,740	217,750	218,650	219,000	238,900	246,750	241,200	231,600	241,800	252,100	264,000
TFP	51,000	56,840	57,950	58,900	53,100	58,900	61,750	62,700	56,700	59,400	63,000	67,500
UDFP	97,515	151,900	159,800	159,750	165,900	180,000	185,000	178,500	174,900	182,400	189,100	196,500
Communication IC	199	200	200	200	200	450	540	600	540	660	750	780
3D sensing module	0	0	0	0	0	0	8,000	10,500	19,800	30,500	45,600	49,500
Total	181,442	246,340	256,450	256,250	254,950	277,850	295,990	293,550	290,440	313,660	340,800	356,630
Revenue (CNYm)												
Touch controller	221	255	265	257	246	265	280	284	265	280	291	291
FP sensor/module	1,003	1,424	1,498	1,504	1,507	1,644	1,698	1,659	1,593	1,664	1,734	1,816
TFP	344	388	399	405	365	405	425	431	390	409	433	464
UDFP	658	1,036	1,099	1,099	1,141	1,238	1,273	1,228	1,203	1,255	1,301	1,352
Communication IC	1	1	1	1	1	3	4	4	4	5	5	5
3D sensing module	0	0	0	0	0	0	55	72	136	210	314	341
Total	1,225	1,680	1,764	1,763	1,754	1,912	2,036	2,020	1,998	2,158	2,345	2,454
Mix by product												
Touch controller	18%	15%	15%	15%	14%	14%	14%	14%	13%	13%	12%	12%
FP sensor/module	82%	85%	85%	85%	86%	86%	83%	82%	80%	77%	74%	74%
UDFP	54%	62%	62%	62%	65%	65%	63%	61%	60%	58%	55%	55%
3D sensing module	0%	0%	0%	0%	0%	0%	3%	4%	7%	10%	13%	14%
Growth (QoQ)												
Touch controller	-6%	15%	4%	-3%	-4%	8%	6%	1%	-7%	6%	4%	0%
FP sensor/module	-10%	42%	5%	0%	0%	9%	3%	-2%	-4%	4%	4%	5%
TFP	3%	13%	3%	2%	-10%	11%	5%	2%	-10%	5%	6%	7%
UDFP	-16%	57%	6%	0%	4%	8%	3%	-4%	-2%	4%	4%	4%
Communication IC	-3%	2%	1%	0%	0%	125%	20%	11%	-10%	22%	14%	4%
3D sensing module	na	na	na	na	na	na	na	31%	89%	54%	50%	9%
Total	-10%	37%	5%	0%	-1%	9%	7%	-1%	-1%	8%	9%	5%
Gross margin												
Touch controller	53%	55%	55%	55%	54%	55%	55%	55%	55%	55%	55%	55%
FP sensor/module	63%	65%	61%	61%	59%	58%	56%	56%	51%	52%	53%	53%
TFP	35%	37%	37%	37%	36%	37%	38%	38%	37%	38%	39%	40%
UDFP	78%	75%	70%	70%	66%	65%	62%	62%	55%	57%	57%	57%
Communication IC	35%	35%	35%	35%	35%	35%	35%	35%	35%	38%	40%	40%
3D sensing module	na	na	na	na	na	na	55%	55%	55%	55%	57%	60%
Total	61%	63%	60%	60%	58%	58%	56%	56%	51%	53%	53%	54%
Gross profit (CNYm)												
Touch controller	117	140	146	142	133	146	154	156	146	154	160	160
FP sensor/module	635	920	917	919	885	955	951	925	806	871	911	956
TFP	120	143	148	150	132	150	161	164	144	155	169	186
UDFP	514	777	770	769	753	805	789	761	662	715	742	771
Communication IC	0	0	0	0	0	1	1	1	1	2	2	2
3D sensing module	0	0	0	0	0	0	30	40	75	115	179	204
Total	752	1,061	1,063	1,061	1,018	1,102	1,136	1,123	1,028	1,142	1,252	1,323

Source: Company, Daiwa estimates & forecasts
*Note: * TFP = traditional fingerprint, UDFP = under-display fingerprint*

Financial analysis

2019 should be a remarkable year for Goodix: we forecast 180% YoY EPS growth for a 35% ROE

Thanks to Goodix's lead in the UDFP product cycle, we forecast the company's top line to increase by 73% YoY for 2019, resulting in strong EPS growth of 180% YoY on margin expansion as Goodix enjoys early-cycle advantages with its lion's share of the UDFP market. Accordingly, its ROE is likely to rise to 35% in 2019 before stabilising at 25-30% pa afterward over our forecast period. Although top-line growth should decelerate after 2019 for a 34% CAGR over 2018-21E, resulting in a 47% EPS CAGR due to likely intensified competition in the UDFP space, we expect Goodix to rebuild its earnings growth cycle from 2H21 when its platform strategy tapping into the IoT/3D cycle bears fruit. For a well-run fabless chipmaker like Goodix, we expect robust cash flows and a strong balance sheet over our forecast period, but we expect it to pay only 20-30% of net profit as cash dividends, given it has to reserve cash for possible acquisitions.

Revenue growth

We forecast Goodix's top line to expand by a 34% CAGR over 2018-21

From only USD13m revenue in 2011, Goodix has expanded its business significantly over the past 8 years, at a 71% revenue CAGR over 2011-18, reaching USD557m (CNY3.7bn) in 2018 thanks to its capability in capitalising on the touch and FP product cycles, as highlighted in the previous section. Despite being far from a top-10 global IC design player (see company profile section on page 28, where the No.10-ranked player UniSoC [紫光展锐] recorded USD1.66bn in revenue in 2018), Goodix has entered China's top-10 fabless chipmaker list and become the largest listed IC designer in China by revenue. We forecast its revenue to see 73% YoY growth this year, reaching CNY6.4bn (over USD900m) against the backdrop of its leading position in the UDFP cycle.

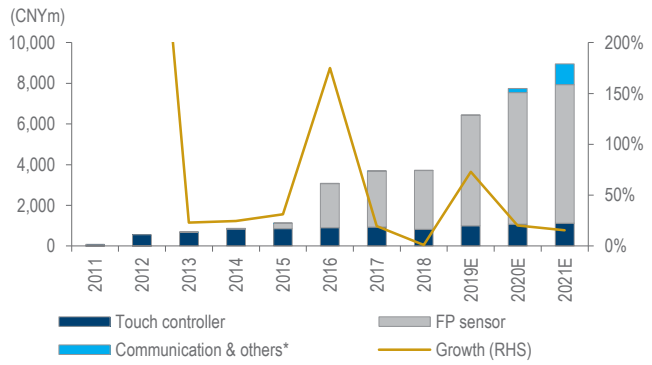
We look for Goodix's revenue growth to decelerate after 2019 to 20% YoY for 2020 and 16% for 2021 for a CAGR of 34% over 2018-21, as we see competition likely compressing UDFP ASP and pressuring gross margin. Nevertheless, on a quarterly basis, we expect growth momentum to once again pick up gradually in 2021 when Goodix's expansion into the next IoT/3D demand cycle starts to bear fruit.

Margin trend

Gross margin has hovered around 47-66% depending on the cycle and scale

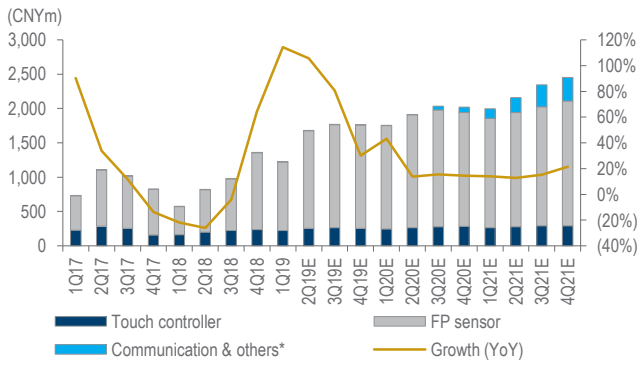
Goodix's gross margin has hovered around 47-66% since 2011 depending on the cycle and scale (like its peers in the IC design industry), where a fabless chipmaker tends to enjoy high margins as a result of high ASPs when it captures the early-entry value of a product cycle (an early-cycle advantage as flagged in the previous section), and scale helps it negotiate favourable wafer and packaging & testing (P&T) pricing with its semiconductor contract manufacturing (SCM) partners. As shown in the chart on the next page, Goodix's cost structure at the COGS level, in terms of FP, is roughly 45-65% for wafers with the rest for chip P&T and/or module assembly, with variances depending on the degree of shipments in module form where extra costs for module assembly have to be paid.

Goodix: revenue trend by product*



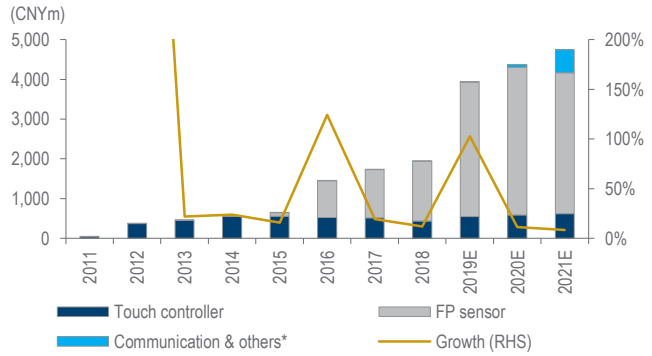
Source: Company, Daiwa estimates & forecasts
*Note: * Including new products such as 3D laser sensing and NB-IoT*

Goodix: quarterly revenue trend by product*



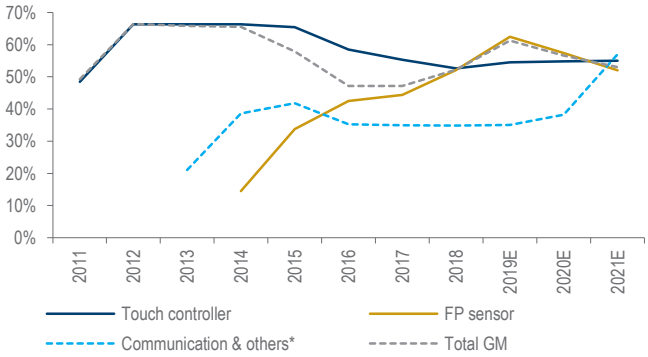
Source: Company, Daiwa estimates & forecasts
*Note: * Including new products such as 3D laser sensing and NB-IoT*

Goodix: gross profit and growth trend



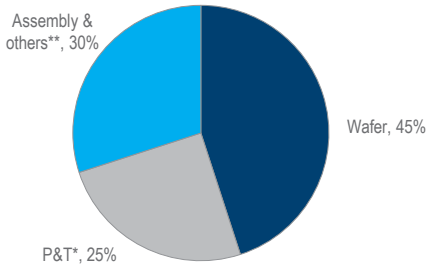
Source: Company, Daiwa estimates & forecasts
*Note: * Including new products such as 3D laser sensing and NB-IoT*

Goodix: gross margin breakdown by product



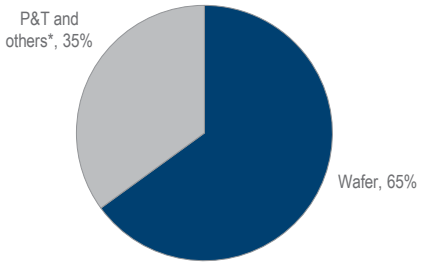
Source: Company, Daiwa estimates & forecasts
*Note: * Including new products such as 3D laser sensing and NB-IoT*

Goodix: FP cost structure for module form (COGS level)



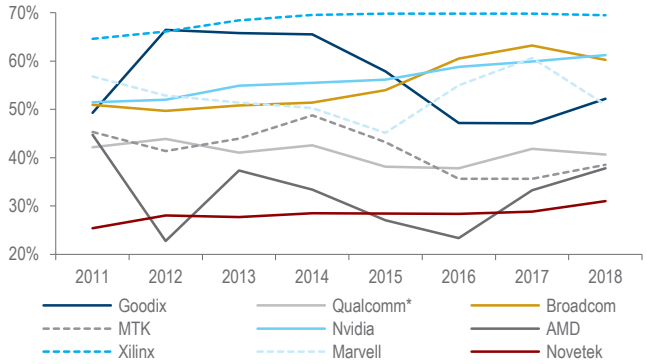
Source: Daiwa estimates & forecasts
*Note: * Packaging & testing; ** mainly module assembly costs*

Goodix: FP cost structure for chip form (COGS level)



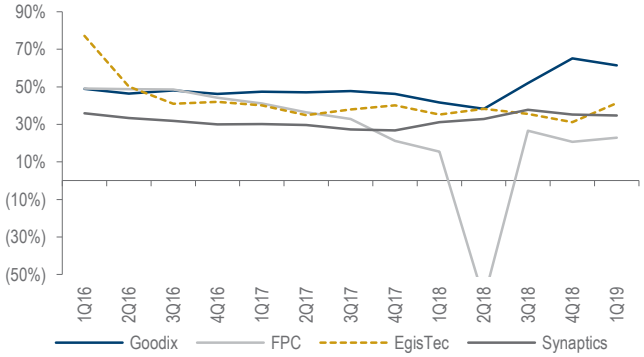
Source: Daiwa estimates & forecasts
*Note: * Mainly packaging & testing costs*

Gross-margin comparison with global fabless majors



Source: Daiwa estimates & forecasts
*Note: * Packaging & testing; ** mainly module assembly costs*

Gross-margin comparison with global FP peers



Source: Daiwa estimates & forecasts
*Note: * Mainly packaging & testing costs*

Goodix's major SCM partners are TSMC, UMC, ASE and Amkor

We forecast Goodix's gross margin to increase to 61% for 2019 as a result of its early-cycle advantages in UDFP, but contract after this year as the competition heats up, until 2021 when its IoT and 3D businesses ramp up and help stabilise its blended gross margin. FP should contribute most of the gross profit, around 85% for 2019-20E, until 2021 when new demand ramps up, and UDFP will likely command some 75% of total FP gross profit over 2019-21E, on our forecasts. Note: according to our market research, Goodix uses TSMC and UMC (Hejian fabs) as its major foundries for wafer fabrication, and ASE and Amkor as its major outsourced semiconductor assembly and test (OSAT) vendors, with tech nodes ranging from 0.18μ to 55nm on 8" and 12" wafer sizes.

Goodix's self-developed algorithms add value to its gross margin

In comparison with global peers in the IC design sector, Goodix had an above-average gross margin, only behind Xilinx, Broadcom and Nvidia over 2011-18. In the FP market, Goodix led the pack in terms of gross margin versus peers including EgisTec, Synaptics and FPC, thanks to its self-developed algorithms, especially for UDFP authentication. Its

self-developed algorithms add value not only to the gross margin but as a tax benefit for its bottom line due to the government's incentives to encourage software development in the country. Other peers tend to license algorithms from third parties, such as Sweden-based Precise and South Korea-based Suprema.

Opex management

Opex ratio likely to hover around 25% after peaking in 2018

Goodix's operating margin ranged from 18% to 49% during 2011-18 (see also table of quarterly P&L forecasts on page 20), and we forecast it to hover around the 30% level over 2019-21, thanks to a decline in the opex ratio as its scale expands. As the chart below depicts, Goodix's opex ratio has risen over the past 8 years due to its start-up status, reaching nearly 35% of revenue in 2018, spurred primarily by increased R&D costs (c.24%). We applaud the company's focus on R&D to prepare for the next product cycle, and expect R&D as a percentage of revenue to decline to a high-teens level over our forecast period on economies of scale, which in turn should largely bring down its opex ratio to c.25% pa over 2020-21, from 27% for 2019E.

Earnings growth

Net profit to expand by a 47% CAGR over 2018-21E

Similar to its top line, Goodix's net profit rose by a solid 61% CAGR over 2011-18, as it benefitted from the touch and FP cycles. Thanks to its lead in the UDFP cycle, we forecast the company's net profit to expand by a strong 180% YoY for 2019 to CNY2.1bn for a CAGR of 47% over 2018-21E. This trend suggests a deceleration in earnings growth after 2019 as a result of our expectation for intensified competition in the UDFP segment, where we forecast Goodix's net profit to reach CNY2.4bn for 2021, implying just single-digit percentage growth pa over 2020-21E before the next IoT/3D demand drivers ramp up.

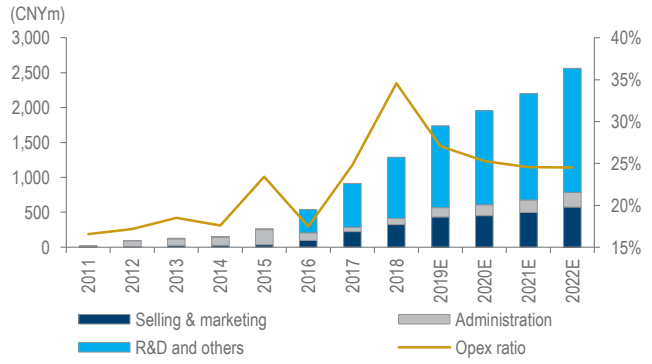
Cash flow and dividends

Goodix should see strong FCF, but is likely to only retain a 20-30% payout ratio for cash dividends

Typically, a well-run fabless chipmaker tends to have solid cash flow due to its asset-light business model where talent is the key asset, while the manufacturing cost burden is borne by its SCM partners. In our opinion, Goodix is a well-run fabless chipmaker, as evidenced by its strong free cash flow (FCF), which we forecast to rise to CNY2.8bn for 2020 – an all-time high despite weakness in 2016 and 2019 as a result of inflated receivables weighing on working capital due to a surge in revenue. As the chart on the next page shows, FCF in 2020 will represent around a 4% FCF yield based on the 12 August closing price.

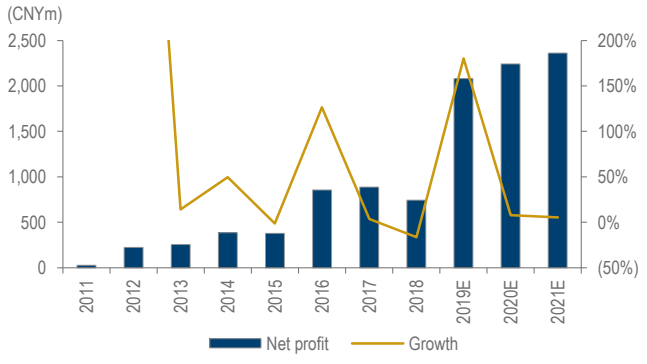
However, Goodix paid only 25-30% of net profit over 2012-18 as a cash dividend, as it aimed to reserve its cash for expansion through potential acquisitions, according to management, given its relatively young status in the IC design industry. We concur with its decision to preserve cash and forecast a 20-30% dividend payout ratio pa over 2020-21. Goodix paid a CNY0.5/share cash dividend in July 2019 for a 31% payout.

Goodix: opex trend



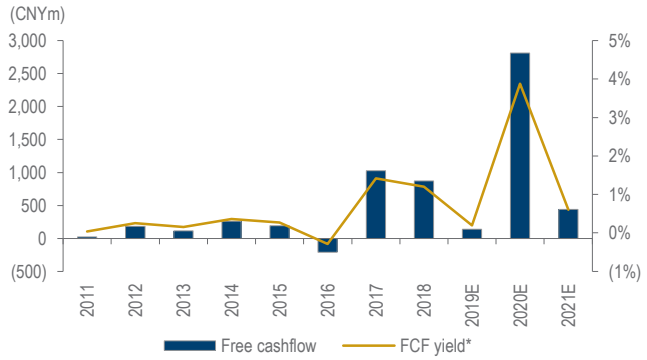
Source: Company, Daiwa estimates & forecasts

Goodix: net-profit trend



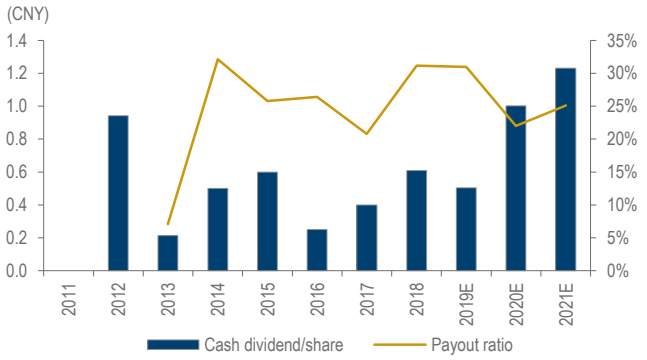
Source: Company, Daiwa estimates & forecasts

Goodix: FCF trend



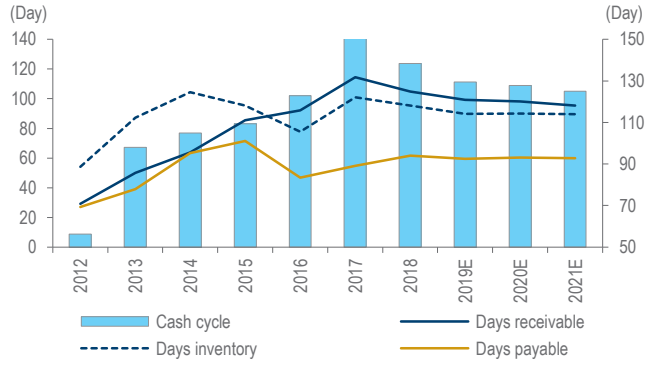
Source: Company, Daiwa estimates & forecasts
*Note: * Based on closing price as of 12 August 2019*

Goodix: cash dividend and payout ratio



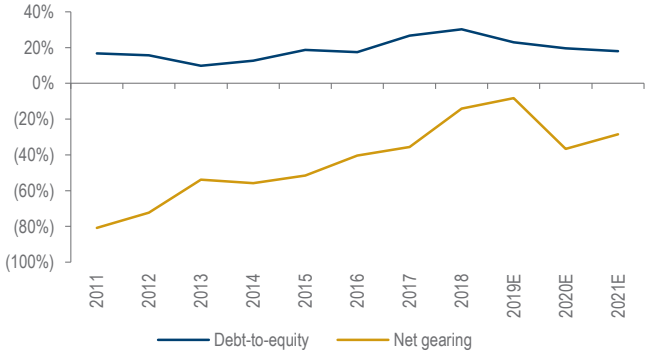
Source: Company, Daiwa estimates & forecasts

Goodix: working capital management



Source: Company, Daiwa estimates & forecasts

Goodix: debt-to-equity ratio and net gearing



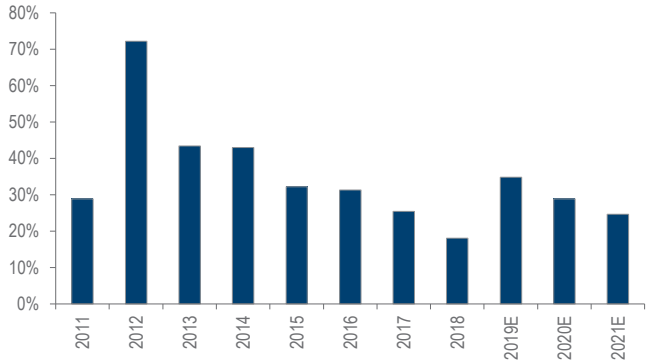
Source: Company, Daiwa estimates & forecasts

Balance sheet

ROE should surge this year thanks to the UDFP cycle

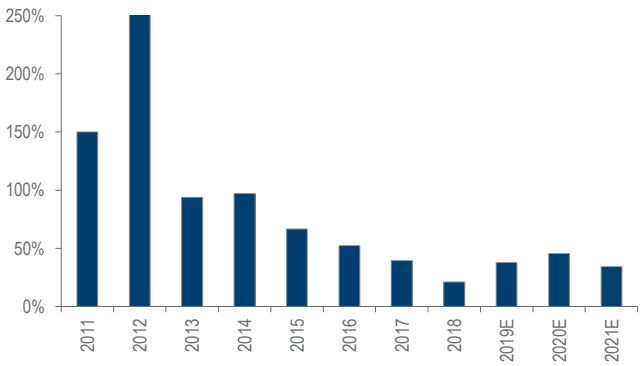
A well-run fabless chipmaker tends to manage a strong balance sheet with net-cash operations and decent ROE/ROIC. Goodix has operated a debt-free balance sheet since 2011, constantly with a net-cash position, where ROE and ROIC tended to hover mostly around the 30% and 60% level, respectively, during 2011-18, despite the volatility in product cycles. We expect its balance sheet to remain strong over 2019-21, with ROE and ROIC surging to 35% and 38% for 2019E on its lead in the UDFP cycle, and then hovering around 25-30% and 35-45% pa, respectively, over our forecast horizon. Note: the ROE and ROIC calculation here are based on single-year equity and invested capital at year-end, not 2-year averages.

Goodix: ROE trend



Source: Company, Daiwa forecasts

Goodix: ROIC trend



Source: Company, Daiwa estimates & forecasts

Near-term update

We expect Goodix's 2Q19 results to beat the street and help catalyse the stock to the upside

Goodix is scheduled to report its 2Q19 earnings results and discuss its 2H19 business outlook in the first week of September, per our check with management. We expect the company to post a net profit of CNY572m for 2Q for EPS of CNY1.25, up 38% QoQ (up more than 500% YoY) and 34% above the consensus estimate (see also the P&L table next page), attributable to a higher top-line and tax benefits.

We estimate Goodix recorded revenue of CNY1.68bn for 2Q19, up 37% QoQ (+106% YoY) and 31% above the consensus estimate, likely on our better assumptions for its FP shipments where we believe Goodix still commanded at least a 90% share of the UDFP market in 2Q (optical only), plus share gains in the traditional FP market. While it incurred a 16.7% income tax rate in 1Q19, we estimate only 5% for 2Q since we expect Goodix to have enjoyed a CNY25-30m tax benefit on value-added software sales (ie, the FP algorithms it has developed in house), thanks to the China government's incentives for software development in the country's tech sector. We expect the street to revise up its earnings forecasts after the results, helping catalyse the stock to the upside in the next 12 months.

Moving into 3Q19, our top-line and bottom-line forecasts are 17-18% higher than the consensus, likely given our view that: 1) the street is too bearish on the Huawei impact for Goodix's smartphone-related business, especially the FP business, and 2) UDFP shipments will continue to increase (up 10% QoQ for 3Q19, on our forecasts), despite a likely contraction in market share on rising competition inducing price erosion.

Goodix: 2Q19 results preview and 3Q19 outlook

	2Q19			3Q19E		
CNYm	Daiwa	Consensus	Variance	Daiwa	Consensus	Variance
Revenue	1,680	1,280	31%	1,764	1,494	18%
Gross profit	1,061			1,063		
Operating profit	591			596		
Pretax profit	602			607		
Net profit	572	427	34%	546	468	17%
Adjusted EPS (CNY)	1.25	0.94	34%	1.20	1.03	17%
Margin						
Gross	63.2%			60.3%		
Operating	35.2%			33.8%		
Net	34.0%			31.0%		
Revenue mix						
Touch	15%			15%		
Fingerprint	85%			85%		
Communication & others*	0%			0%		

Source: Company, Bloomberg, Daiwa estimates & forecasts
*Note: * Other products including NB-IoT and 3D laser sensing*

Goodix: quarterly P&L forecasts

CNYm	1Q18	2Q18	3Q18	4Q18	1Q19	2Q19E	3Q19E	4Q19E	2018	2019E	2020E	2021E
Revenue	571	817	977	1,356	1,225	1,680	1,764	1,763	3,721	6,432	7,722	8,955
COGS	-334	-504	-470	-472	-472	-619	-701	-702	-1,779	-2,494	-3,343	-4,210
Gross profit	238	313	507	884	752	1,061	1,063	1,061	1,942	3,938	4,379	4,745
Opex	-228	-283	-306	-471	-339	-470	-468	-464	-1,286	-1,740	-1,956	-2,198
Operating profit	10	30	202	413	414	591	596	598	656	2,198	2,423	2,547
Non-op gain/loss	15	30	37	8	84	11	12	12	91	118	68	77
Pretax profit	25	60	239	421	497	602	607	609	746	2,315	2,491	2,624
Income taxes	-6	32	-33	2	-83	-30	-61	-61	-4	-235	-249	-262
Net profit	19	93	207	424	414	572	546	548	742	2,081	2,242	2,361
EPS (CNY, basic)	0.04	0.20	0.45	0.93	0.91	1.25	1.20	1.20	1.63	4.56	4.91	5.17
EPS (CNY, fully diluted)	0.04	0.20	0.45	0.93	0.91	1.25	1.20	1.20	1.63	4.56	4.91	5.17
Margin												
Gross	42%	38%	52%	65%	61%	63%	60%	60%	52%	61%	57%	53%
Operating	2%	4%	21%	30%	34%	35%	34%	34%	18%	34%	31%	28%
Net	3%	11%	21%	31%	34%	34%	31%	31%	20%	32%	29%	26%
Growth (QoQ)												
Revenue	-31%	43%	20%	39%	-10%	37%	5%	0%				
Gross profit	-38%	32%	62%	74%	-15%	41%	0%	0%				
Operating profit	-86%	199%	567%	105%	0%	43%	1%	0%				
Net profit	-84%	380%	122%	105%	-2%	38%	-4%	0%				
EPS (basic)	-84%	377%	122%	105%	-2%	38%	-4%	0%				
EPS (FD)	-84%	377%	122%	105%	-2%	38%	-4%	0%				
Growth (YoY)												
Revenue	-22%	-26%	-4%	64%	114%	106%	81%	30%	1%	73%	20%	16%
Gross profit	-31%	-40%	4%	132%	217%	239%	110%	20%	12%	103%	11%	8%
Operating profit	-95%	-91%	-16%	467%	nm	nm	195%	45%	-20%	235%	10%	5%
Net profit	-89%	-70%	-26%	241%	nm	516%	165%	29%	-16%	180%	8%	5%
EPS (basic)	-89%	-71%	-27%	239%	nm	516%	165%	29%	-17%	180%	8%	5%
EPS (FD)	-89%	-71%	-27%	239%	nm	516%	165%	29%	-17%	180%	8%	5%

Source: Company, Daiwa estimates & forecasts

Valuation and risks

We normally employ the ROE-adjusted PBR method to value chipmakers which own fabs; but for the fabless chipmakers, we use a forward-PER valuation owing to their high earnings-growth profile, especially when they capture the right product cycle, regardless of also likely high volatility amid their business transition between cycles.

We set our 12-month TP at CNY180

We set our 12-month target price for Goodix at CNY180, based on a 4-quarter forward PER of 37x, which calls for an Outperform (2) rating according to Daiwa's rating system. In our opinion, the key downside risk for Goodix is China-US trade tensions hurting its key customer Huawei's smartphone business. On the flip side, a potential catalyst could come from any commercialisation of LCD-version UDFP solutions adding to Goodix's earnings upside.

Forward PER valuation

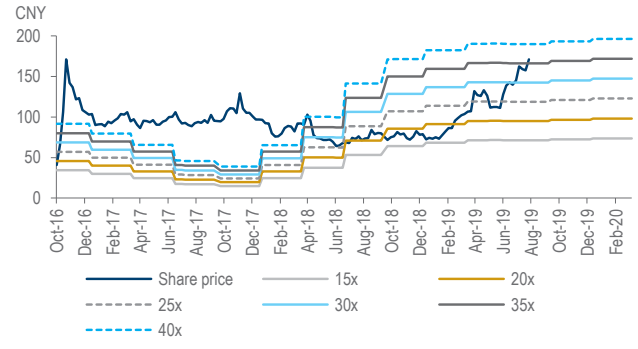
Positioning Goodix as a growth stock against the backdrop of its young status in the IC design sector embracing multiple demand drivers, we employ the 4-quarter forward PER method to calculate its fair value. We forecast Goodix's structural net profit growth to be 20-40% pa over a 3-5 year timeframe, eliminating volatility in between cycle transitions. Thanks to its strong 2019 showing on its lead in the UDFP cycle, we forecast its net profit to rise by a 47% CAGR over 2018-21. Therefore, in consideration of the 2 different growth rates, we apply a 37x PER to its forward EPS over 4Q19-3Q20, which we see as reasonably capturing its fair PER/earnings growth (PEG) profile. This derives our 12-month TP of CNY180; we thus initiate on the stock with an Outperform (2) call based on Daiwa's rating system.

While some may be concerned about a possible deceleration in Goodix's earnings growth after this year when the UDFP demand cycle plateaus, thereby adversely impacting its valuation, we see LCD UDFP, if it materialises, becoming another commercial solution for the Android smartphone vendors, which could potentially lift Goodix's EPS growth to 30-35% pa over 2020-21. Accordingly, we see our 37x target PER as not overly demanding.

Risks to our call

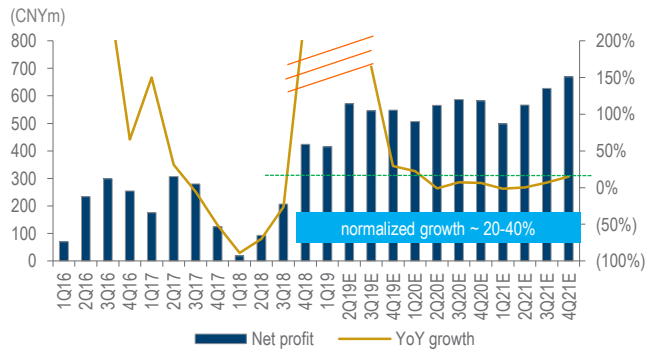
We identify 3 issues below as the key downside risks to our positive stance on Goodix, while one catalyst could come in the form of potential commercialisation of the LCD UDFP.

Goodix: 4-quarter forward PER bands



Source: Company, Bloomberg, Daiwa estimates & forecasts

Goodix: quarterly earnings growth trend



Source: Company, Daiwa estimates & forecasts

Downside risks

- **China-US trade tensions.** The pending trade war has caused concern in the market since 2018, not only at the company level but for the tech sector as a whole, especially when Huawei was put on the Entity List by the US on 16 May. This move could also affect Goodix given that Huawei is perhaps its largest customer, accounting for over 30% of revenue. While the issue looks to have been alleviated to some extent post the Osaka G20 Summit (see our memo, *Implications on tech sector from the G20 meeting: back to square one*, 1 July), we estimate some high single-digit percentage earnings impact against Goodix for 2019, c. 15-20% each for 2020-21, should this issue come back to haunt us at the worst-case scenario, since Huawei remains on the Entity List.

- **UDFP competition.** Like many other new product cycles in the IC design space, the fast-growing UDFP cycle has brought competition. Our recent visit to EgisTec suggests that the company has started commercialising its UDFP solutions for an Android smartphone major, and we understand Silead is also ramping up UDFP for local smartphone vendors in China, despite pending litigation from Goodix against the 2 companies (note: Goodix sued Silead on 6 November 2018 and EgisTec on 8 July 2019 for patent violations against the former's optical UDFP technologies). We expect competition in the UDFP market to heat up and are modelling some 5% QoQ price erosion starting from 2H19, with Goodix seeing market share contracting to below 60% by 2021, although this product cycle is still young with volume expanding rapidly. Should the competition turn out to be more intense than we expect, Goodix could lose more market share or price erosion could turn out deeper to push earnings to the downside.

- **3D sensing cycle.** We've envisioned a structural demand cycle for the 3D laser sensing & imaging technologies since 2017 when Apple adopted VCSEL sensors as Face ID for iPhone X (see our 3D laser thematic report published in June 2017, *Asian Optical Sensing & Communication: A whole new world*, for more details). Although Goodix hasn't tapped into this market, which is still young, a downside risk to our forecasts, especially in 2021 when we expect Goodix to ramp up its 3D solutions, could emerge should 3D laser technologies fail to materialise as a secular trend in the smartphone market as we expect.

Potential catalysts

As discussed in the FP market analysis section (page 24-27), the LCD-version UDFP would be a potential catalyst for Goodix's earnings if it successfully commercialises this solution and expands its addressable market, where the LCD smartphones could be 1.5x that of the OLED counterparts in shipment size (Android only). And assuming Goodix were to ramp up its LCD UDFP solutions at a similar trajectory to that of its OLED UDFP, we believe it is possible its net profit would increase by 25-50% over 2020-21, lifting the fair value of the stock to CNY255, assuming a 37x PER applied to our average 2020-21E EPS.

Global IC design sector peer valuation panel

Stock	Ticker	Price (LC)*	MktCap (USDm)	PER (x) 2018	PER (x) 2019E	PER (x) 2020E	PBR (x) 2018	PBR (x) 2019E	PBR (x) 2020E	ROE (%) 2018	ROE (%) 2019E	ROE (%) 2020E	Earnings growth (%) 2018	Earnings growth (%) 2019E	Earnings growth (%) 2020E
Networking & communication															
Broadcom	AVGO US	275.73	109,761	9.2	11.7	10.7	4.1	5.6	6.0	44.6	48.1	55.6	429.7	-20.8	8.8
Qualcomm**	QCOM US	71.50	86,920	16.0	20.6	17.6	93.7	30.0	11.2	586.6	145.8	63.4	-14.8	-22.4	16.9
MediaTek	2454 TT	323.00	16,381	24.7	19.6	15.2	1.9	1.8	1.7	7.6	9.3	11.3	-14.7	26.0	29.1
Marvell	MRVL US	24.72	16,340	71.0	31.4	19.3	2.2	2.2	2.2	3.1	7.1	11.1	-57.6	126.0	62.3
Xilinx	XLNX US	104.23	26,329	29.6	24.8	16.4	9.2	8.0	6.5	31.1	32.3	39.3	31.1	19.2	51.1
Realtek	2379 TT	208.50	3,380	24.3	16.1	15.5	4.3	3.9	3.5	17.7	24.1	22.6	28.3	51.6	3.5
Average				29.1	20.7	15.8	19.2	8.6	5.2	115.1	44.5	33.9	67.0	30.0	28.6
Graphics & HPC															
Nvidia	NVDA US	154.18	93,896	22.7	28.9	22.9	10.1	12.6	10.6	44.3	43.8	46.2	34.3	-21.5	26.2
AMD	AMD US	34.19	37,115	72.2	48.8	30.4	29.3	12.8	6.8	40.6	26.1	22.3	399.0	47.9	60.8
Average				47.4	38.9	26.6	19.7	12.7	8.7	42.5	35.0	34.2	216.7	13.2	43.5
Display driver & SoC															
Novatek	3034 TT	166.00	3,222	15.8	11.9	11.0	3.3	3.0	2.9	21.1	25.3	26.0	27.2	32.4	8.6
Himax	HIMX US	2.34	403	47.0	na	na	0.9	0.9	0.9	1.9	-5.9	-6.0	-69.4	na	na
Average				31.4	11.9	11.0	2.1	2.0	1.9	11.5	9.7	10.0	-21.1	32.4	8.6
Touch & fingerprint															
Goodix	**603160 CH**	**170.90**	**11,066**	**105.0**	**37.5**	**34.8**	**19.0**	**13.0**	**10.0**	**18.1**	**34.8**	**28.8**	**-16.3**	**180.2**	**7.8**
Synaptics	SYNA US	33.75	1,164	29.2	11.1	10.2	1.6	1.7	1.6	5.5	15.5	16.0	-46.7	162.8	9.3
FPC	FINGB SS	17.06	561	na	na	117.7	3.0	3.0	2.9	-25.8	0.0	2.5	na	na	na
EgisTec	6462 TT	235.00	533	24.9	12.8	10.1	7.0	5.5	4.6	28.0	42.7	45.5	13.1	95.1	27.0
Average				53.0	20.4	43.2	7.6	5.8	4.8	6.4	23.2	23.2	-16.6	146.0	14.7
Power, audio & other consumer SoC															
Dialog Semi	DLG GR	39.89	3,240	16.3	12.7	15.5	2.2	1.8	1.7	13.6	14.0	10.7	-8.3	28.6	-18.2
Cirrus Logic	CRUS US	53.10	3,087	44.0	19.7	17.8	2.7	na	na	6.2	na	na	-55.2	122.7	11.1
Silicon Lab	SLAB US	105.33	4,565	49.1	33.2	28.4	4.3	na	na	8.7	na	na	43.2	48.0	17.1
Average				**36.5**	**21.9**	**20.5**	**3.1**	**1.8**	**1.7**	**9.5**	**14.0**	**10.7**	**-6.8**	**66.4**	**3.4**
Grand average				**37.6**	**22.7**	**24.6**	**11.7**	**7.1**	**4.9**	**50.2**	**30.9**	**26.4**	**45.2**	**58.4**	**21.4**

Source: Bloomberg (not rated companies), Daiwa forecasts (rated companies)

*Note: *Local currency, based on share prices as of 9 August 2019, Taiwanese and Chinese companies share prices as of 12 August 2019; January year-end for Marvell, Nvidia; March year-end for Xilinx, Cirrus Logic; June year-end for Synaptics; September year-end for Qualcomm; October year-end for Broadcom*

Fingerprint market analysis

UDFP is the focus for growth, with an LCD-version potentially extending its life cycle

Enjoying a high-growth cycle over 2013-17, the global FP-enabled smartphone market will only deliver a 5% CAGR over 2018-21 in shipment terms, according to our forecasts. Yet we expect the ramp-up of UDFP to lead the growth, achieving a strong 130% CAGR over the same period in shipment terms; we expect Goodix to lead this new product cycle and sustain its leadership in the FP market despite a possible compression of its market share as a result of competition. Price erosion however, will likely be inevitable due to competition from the likes of EgisTec and Silead, leading to a potential deceleration in the UDFP cycle after 2020 in revenue terms. Nevertheless, FP suppliers' likely expansion of their footprints into Android LCD smartphones would offer upside potential for extending their technology reach and expanding the FP suppliers' addressable markets.

Global FP market forecasts

Moto's Atrix was the first FP-enabled smartphone

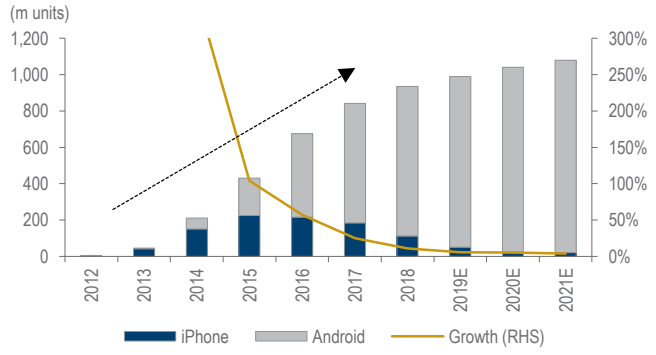
As one of the biometric authentication technologies, FP sensing technology has been in development for decades and was prototyped in the 1990s by Siemens in the mobile phone space. While the first FP-enabled smartphone was unveiled in 2011 (the Motorola Atrix), its scale was limited due to the lack of any push by market leaders. However, in 2013, Apple began to adopt FP technology in its phones (iPhone 5S) for security control (ie, Touch ID) following its acquisition of AuthenTec in 2012, which designed FP hardware and algorithm solutions. Android smartphone vendors followed suit to help accelerate the addressable market.

We forecast only a 5% CAGR for FP-enabled smartphone shipments over 2018-21

FP-enabled smartphones enjoyed high growth over 2013-17 (see chart below), virtually doubling shipment volume each year on average until 2017 when Apple started replacing its FP authentication with 3D laser sensing & imaging technology (ie, Face ID for iPhone X). Reaching 935m units in 2018 with around a 60% penetration in the smartphone market, FP-enabled smartphones will see only a 5% CAGR over 2018-21 in shipment terms, per our forecasts, despite penetration potentially rising to 70% in 2021, for 3 reasons:

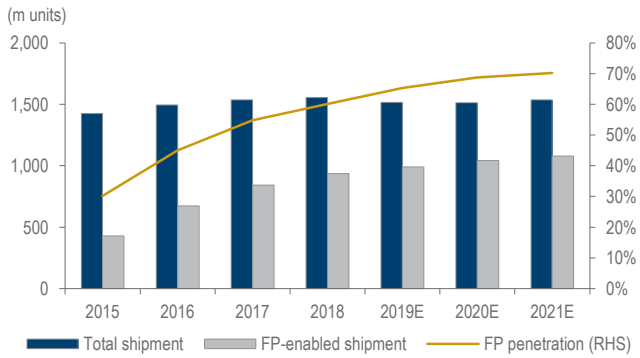
- Muted global smartphone demand growth, where we forecast shipments to decline by 3% YoY this year, picking up slightly after 2020 on 5G cellular migration for just a flat CAGR over 2018-21.
- iPhones ramping down FP solutions with quick replacement of Face ID, where all the 2018 models (iPhone XR, XS and XS Max) removed Touch ID for biometric authentication; and we expect a similar trend for 2019 new models.
- Rising adoption of UDFP cannibalising the traditional FP (TFP) (capacitive type), as a result of smartphone vendors' full-screen design aimed at retaining consumer traction.

FP-enabled smartphone shipment forecasts*



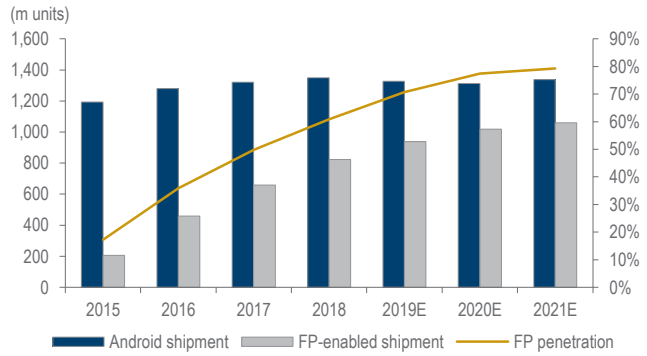
Source: Daiwa estimates & forecasts
*Note: * Including all technology types of capacitive, optical and ultrasonic*

FP penetration in global smartphone market*



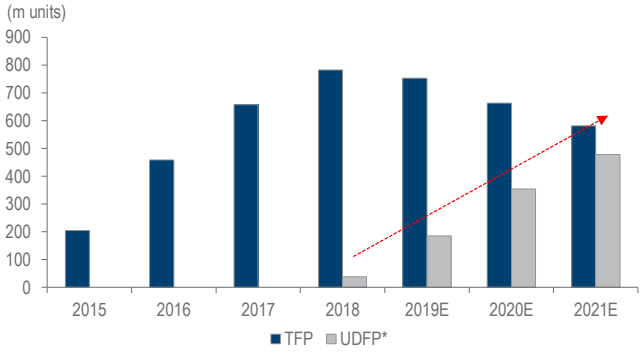
Source: IDC, Daiwa estimates & forecasts
*Note: * Including iOS and Android platforms*

FP penetration in Android smartphone market



Source: IDC, Daiwa estimates & forecasts

Android smartphone shipment forecasts by FP type



Source: Daiwa estimates & forecasts

Nevertheless, since 2018 UDFP has become the focus of replacement demand for growth when leading suppliers like Goodix and Synaptics commercialised their solutions. Because Apple has abandoned the FP solution in its phones (we expect less than 15% adoption in 2020 for legacy models only), our discussion here focuses on Android smartphones for the demand dynamics between TFP and UDFP.

UDFP the focal trend

UDFP stands to lead the growth with a strong 130% shipment CAGR over 2018-21E

As illustrated in the chart above, FP-enabled Android smartphone shipments reached 822m units, on our estimates, for 61% penetration in 2018, and we forecast shipments to exceed 1bn in 2021 for a 9% CAGR, with penetration approaching 80% for the Android platform. Whereas we see TFP solutions contracting at a 9% CAGR over 2018-21, we forecast UDFP-enabled Android phone shipments to expand at a 130% CAGR during the same period and reach nearly 480m units in 2021, from 39m in 2018 and 185m in 2019. These forecasts reflect our view that UDFP is the focal trend for growth in the global smartphone market, and players that fail to jump quickly onto this new product cycle will be marginalised – a phenomenon commonly occurring in the IC design industry.

Optical type over ultrasonic

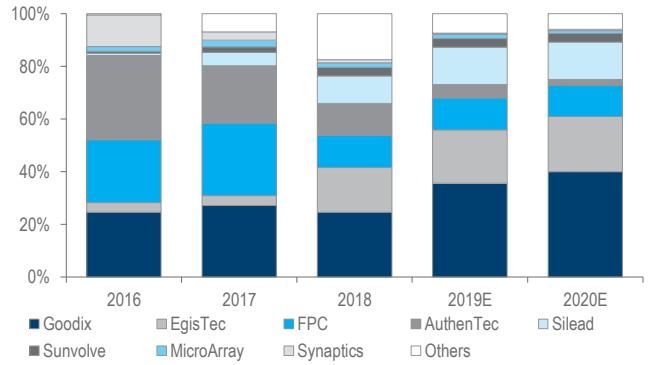
Between the 2 types of sensing technologies used in UDFP, optical and ultrasonic (see Appendix 1 for a technological elaboration), we expect the ultrasonic type to be a niche segment in 2019-21, with a single-digit share, where Samsung Electronics (SEC) and Qualcomm are the primary promoters of this technology. The optical type of UDFP, on the other hand, should command the lion's share thanks to its technological advantage (easier to produce at lower cost) over ultrasonic, which has led to optical gaining traction among most Android smartphone vendors.

Goodix likely to lead the trend

Global FP market share has changed hands in recent years, but we expect Goodix to sustain its leadership

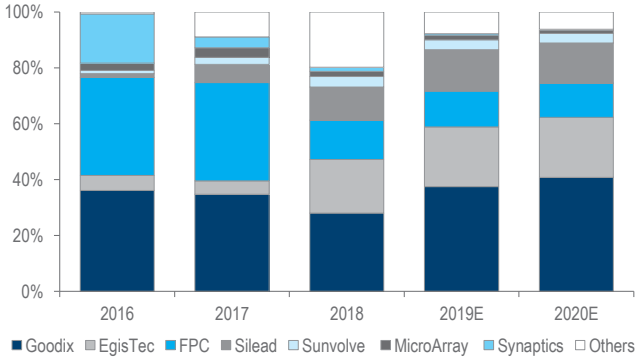
The global FP market has seen drastic share reshuffles in recent years, as depicted in the chart on the next page, as a result of intense competition from the Greater China region. In 2016, some 90% of the FP market was controlled by AuthenTec (32%), Goodix (25%), FPC (24%) and Synaptics (12%). Yet in 2018, EgisTec and Silead replaced Synaptics in terms of ranking, while Synaptics decided to exit the smartphone FP market this year to focus on IoT and automotive applications, according to our market research. This year, we look for Goodix to expand its market share by some 10pp YoY to 36%, sustaining its leadership thanks to its lead in the UDFP cycle, followed by EgisTec and Silead, which we see increasing their market shares by 4pp to 20% and 15%, respectively. While FPC may keep its market share at a low-teen percentage, AuthenTec's looks poised to drop meaningfully, on our estimates, to c.5% as a result of Apple's shift to 3D laser sensing.

Global FP market share by shipments*



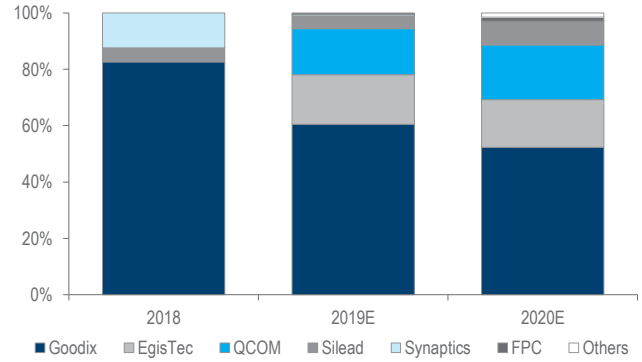
Source: Daiwa estimates & forecasts
*Note: * Including all technology types of capacitive, optical and ultrasonic*

Android FP market share by shipments*



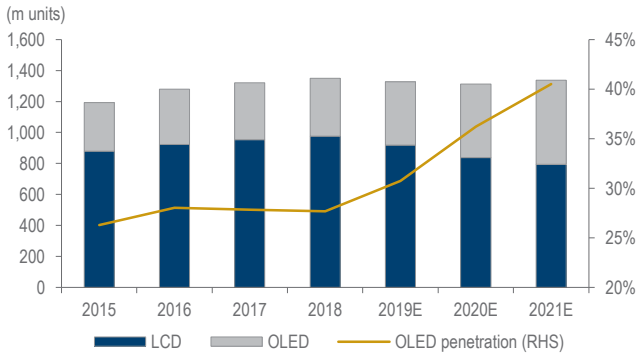
Source: Daiwa estimates & forecasts
*Note: * Including all technology types of capacitive, optical and ultrasonic*

Global UDFP market share by shipments*



Source: Daiwa estimates & forecasts
*Note: * Android smartphones only, including optical and ultrasonic types*

Smartphone shipment breakdown by display*



Source: Daiwa estimates & forecasts
*Note: * Android smartphones only*

On our estimates, Goodix commanded over 80% of the UDFP market in 2018, followed by Synaptics and Silead. We forecast its market share to drop to 65% this year and c.50% in 2020 as result of competition from the likes of EgisTec, Qualcomm and Silead, despite Synaptics' retreat. Novatek's (3034 TT, TWD166, Outperform [2]) decision to enter this market may add to competition next year. Although we expect volume to expand meaningfully over 2018-21 to accommodate these players, rising competition, especially in the optical-type segment, will likely erode prices. Goodix expects at least 5% QoQ price erosion per quarter over the next 1-2 years, which we see as reasonable.

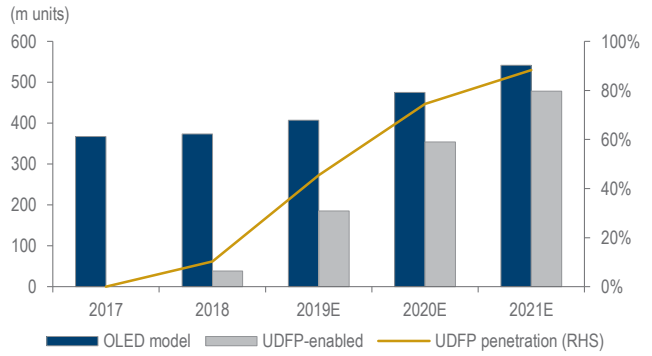
Note: Goodix, EgisTec and Silead focus on optical UDFP, while Qualcomm and FPC focus on ultrasonic-type technology.

LCD may add to upside

Although price erosion looks a concern in the UDFP market, penetrating the LCD model may offer upside to help mitigate the impact

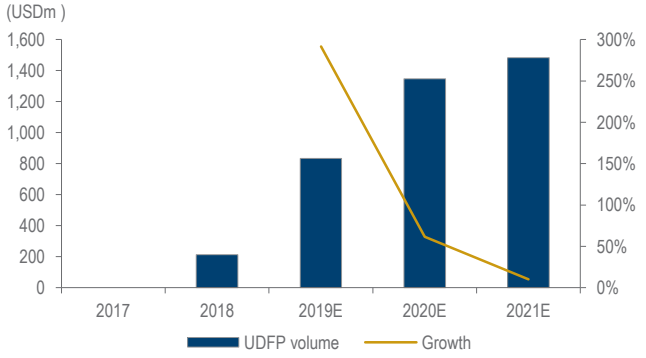
Currently, UDFP solutions focus on smartphones configured with screen-display types of organic light emitting diode (OLED) technology; therefore market players use OLED smartphone penetration as a ceiling for UDFP growth despite its still-young product cycle. On our forecasts, shipments of OLED smartphones on the Android platform will reach 400m this year and 475m next, for penetration of 31% and 36%, respectively, delivering a CAGR of 13% over 2018-21 regardless of muted Android smartphone growth overall. This translates into an addressable market of 540m units in 2021 for UDFP, or 170m units on an incremental basis over the 3-year timeframe. While our assumptions call for 45% UDFP penetration for Android OLED smartphones for 2019, 75% for 2020, and 88% for 2021 (chart, next page), we see upside potential for FP vendors to expand their addressable markets by developing their UDFP solutions for LCD-configured smartphones.

UDFP penetration in OLED smartphone market*



Source: Daiwa estimates & forecasts
*Note: * Android smartphones only, including optical and ultrasonic types*

UDFP market forecasts by revenue*



Source: Daiwa estimates & forecasts
*Note: * Including optical and ultrasonic types*

We see LCD-version UDFP adding to the earnings upside for Goodix

We believe Goodix is working on this UDFP solution for LCD smartphones, likely sampling it with Android smartphone vendors in 3Q19 with a possibility of commercialising the solution in 2020 depending on market demand, execution of technology, and the price/performance proposition. LCD smartphone shipments in the Android space were 2.6x those for OLED smartphones last year and should still lead in 2021 despite the latter's rising penetration (from 28% in 2018 to 40% in 2021 on our forecasts), thus suggesting meaningful upside potential for UDFP solutions. We forecast nearly 800m LCD smartphone shipments in 2021 for the Android market; we do not factor any LCD contribution into our forecasts due to the lack of a proven track record as the technology is still immature, but instead treat it as upside potential for UDFP suppliers' earnings.

Company profile

Goodix was founded in 2002 by Mr. Fan Zhang, who holds a 48% stake

Founded in 2002 by Mr. Fan Zhang (張帆), the president and CEO, Shenzhen Goodix Technology (深圳匯頂科技) (Goodix) is a China-based fabless chipmaker (ie, an IC design house) headquartered in Shenzhen, Guangdong Province. Goodix started its business with communication ICs for fixed-line telephones, and then expanded its product reach to capacitive type touch controller ICs. In our opinion, thanks to MTK's investment in 2011, Goodix reached a milestone in 2013 by leveraging MTK's reference-design platform in China's smartphone market, ramping up its revenue to exceed the USD100m mark and riding on the smartphone "touch cycle".

Growing through the touch and FP cycles, Goodix has delivered strong revenue and earnings growth over the past 8 years

Goodix further expanded its footprint to FP authentication technologies, offering capacitive-type FP sensors and modules for mobile devices such as smartphones and tablets and lifting its revenue scale above the USD500m mark in 2017 through share gains in China's FP market against the likes of FPC and Synaptics despite its late-comer status. As capacitive FP lost traction with smartphone vendors, which began pushing full-screen designs with OLED in 2018, Goodix this time took the driver's seat, leading in the UDFP product cycle starting from 2H18. Over 2011-18, it grew its top line by a strong 71% CAGR for bottom-line growth of a 61% CAGR, managing gross and operating margins of 47-66% and 18-49% pa, respectively.

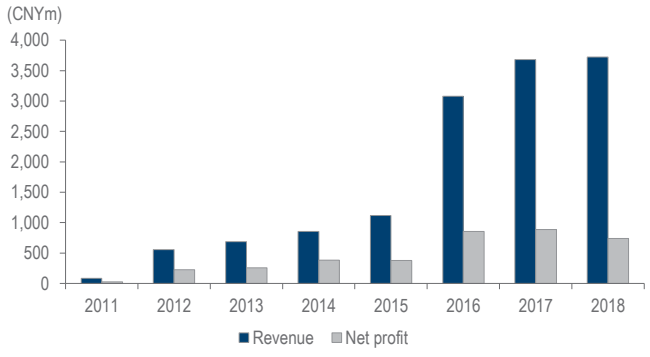
Commanding some 90% of the UDFP market in 1H19 (optical only, excluding ultrasonic), on our estimates, Goodix is pre-empting its competition by transforming its business model from product vendor to platform provider, aiming to offer integrated solutions centring on its 3 fundamental technologies, namely, data sensing, data computing and data transmission, to capitalise on the IoT markets. This meets one of our investment themes – HMI, under the BigData/IoT cycle – we have flagged to enjoy secular demand growth (see our 2019 Tech Outlook report, *A year of new leadership*, 7 January, for more details).

Industry position

Goodix was No.6 in China by revenue in 2018

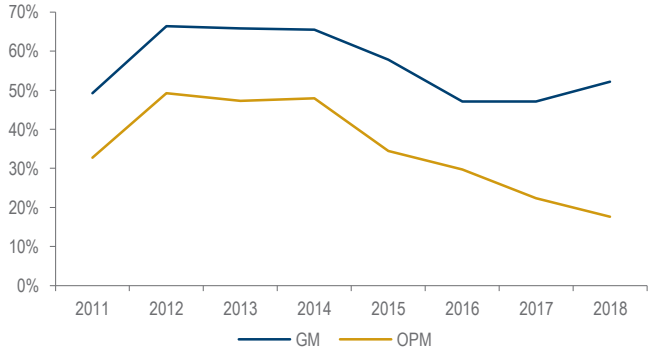
Given its short history and limited scale relative to global peers, Goodix is not in the top-10 global IC design house list, where the 10th player, UniSoC (紫光展銳), recorded USD1.66bn in revenue last year, nearly 3x that of Goodix. However, as illustrated in a chart next page, Goodix was in the top-10 list of China's IC design industry by revenue in 2018, ranked No.6 behind HiSilicon (海思半導體), UniSoC, OmniVision (北京豪威), Sanechips (中興微電子) and Huada Semiconductor (華大半導體). We look for Goodix's revenue to exceed the USD1bn mark in 2020, based on our expectation that its revenue run-rate will ride on the UDFP product cycle.

Goodix: revenue and profit trend (2011-18)



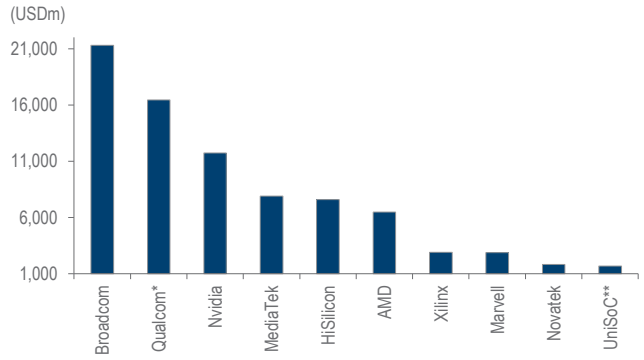
Source: Company

Goodix: gross- and operating-margin trends



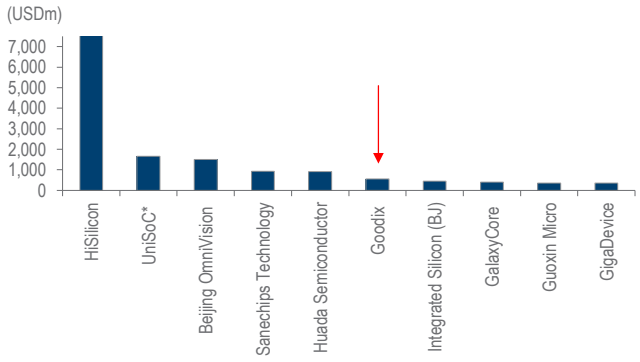
Source: Company

2018 top-10 global IC design houses



Source: Company, Daiwa estimates
*Note: * QCT revenue only (ex-QTL); ** Unigroup including Spreadtrum and RDA*

2018 top-10 China IC design houses



Source: Company, Daiwa estimates
*Note: * Unigroup including Spreadtrum and RDA after privatization*

Sales mix

We forecast FP to contribute over 80% of revenue in 2019-20E

Goodix's revenue mix has varied over the past decade due to the different product cycles it has been through, from fixed-line telephone ICs to touch controllers to FP. As of 2018, FP accounted for most of its revenue, or 78% of the total on our estimates, where traditional capacitive type (TFP) took 44%. In 1H19, the mix was geared towards UDFP, which accounted for 58% of revenue, on our estimates. We expect this situation to continue until Goodix expands revenue into the next product cycles of IoT and 3D laser sensing.

Customer base

Virtually all China smartphone brands are Goodix's customers

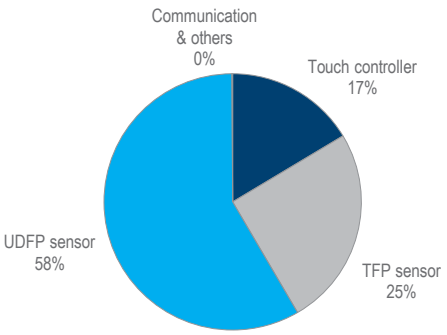
Goodix derives roughly 80% of its revenue from domestic China while the rest comes from overseas, with customers spanning almost all the Android smartphone majors in China as shown in the chart below, ranked by 2018 market share in shipment terms. We believe Huawei is Goodix's largest customer here. In addition to the smartphone vendors, Goodix does business with global leading tablet and smart-speaker vendors such as Dell, Google and Amazon, to name a few.

Cost structure

Split between wafer and SAT costs: 55:45 for touch, 45:25:30 for FP

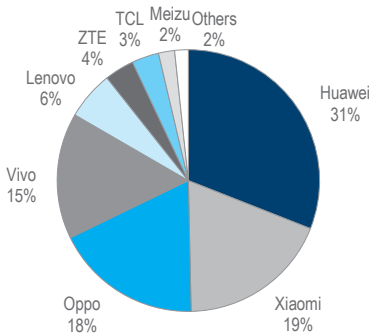
A typical IC design house incurs only wafer and packaging & testing (P&T) costs at the COGS level, given its fabless business model with roughly a 2:1 split between the front end and back end despite, with some variance depending on technology levels in the front-end wafer foundry and back-end semiconductor assembly & test (SAT). However, extra module assembly costs are incurred if a fabless chipmaker sells a product in module form. Therefore, around 55% of Goodix's COGS are from wafer costs and the rest from SAT for its touch controllers, as it sells this product primarily in chip form; but for its FP products, only around 45% of its COGS are from wafer costs and 25% from SAT, with the rest going to module assembly, particularly UDFP type (see chart, next page).

Goodix: 1H19 revenue mix*



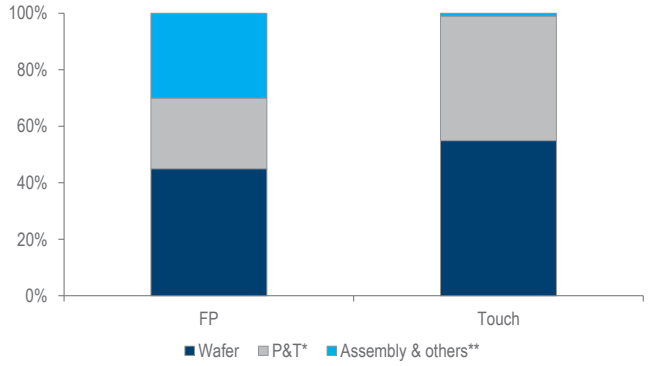
Source: Company, Daiwa estimates
*Note: * In terms of unit shipment*

2018 smartphone market share (China vendors only)*



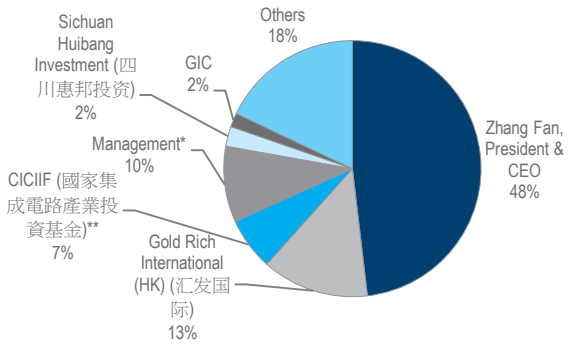
Source: Company, Daiwa estimates
*Note: * In shipment terms*

Goodix: cost structure at COGS level by product



Source: Company, Daiwa estimates
*Note: * packaging & testing; ** mainly module assembly costs*

Goodix: shareholder structure as of 2Q19



Source: Company, Daiwa estimates
*Note: * Excluding Fan Zhang; ** China Integrated Circuit Industry Investment Fund*

Shareholder structure

Key shareholders are Fan Zhang, MTK and the Big Fund

As depicted in the chart above, the founder and president/CEO, Fan Zhang, controls most of Goodix, with a 48% stake as of 2Q19, followed by Gold Rich International (HK) (汇发国际，13%), which is 100%-owned by MTK, as well as China Integrated Circuit Industry Investment Fund (CICIIF, 國家集成電路產業投資基金), or the so-called Big Fund (7%). The top-3 shareholders held nearly 70% of Goodix as of 2Q19.

Free float is around 30%

Excluding Mr. Zhang, management on aggregate commands around a 10% stake, on our estimates, leaving a free float of some 30%. We note that MTK has executed 2 rounds of share disposals post the IPO on 17 October 2016 on the Shanghai Stock Exchange, selling a 5% stake in 2H17 and 2% over 4Q18-1H19. On 1 May this year, MTK announced plans to sell no more than 2% of its stake over 2Q-4Q19. We think it may continue this action going forward, though the timetable is not firm.

Appendix 1: fingerprint technologies

For readers with an interest in engineering, we explain in this section the principles of FP technologies by elaborating on the features and processes of FP identification and authentication. We take a close look at how different FP sensing technologies capture FP images, including capacitive, optical, ultrasonic and thermal types.

FP: the most popular biometrics

Uniqueness and permanence make FP an ideal biometrics commonly used in daily lives

Biometrics is a measurement of the unique biological characteristics of an individual, and biometric authentication using biological characteristics as passcodes has become common in our daily lives, such as for unlocking a phone with face identification, iris scanning or FP recognition, or getting money from an ATM with vein recognition. There is a wide range of biometrics from visual recognition like face or FP to other characteristics that cannot be observed directly, such as vein recognition or deoxyribonucleic acid (DNA) matching. The most popular biometric-authentication technology is FP recognition, which is commonly used in electronic devices to security systems.

Features of an FP

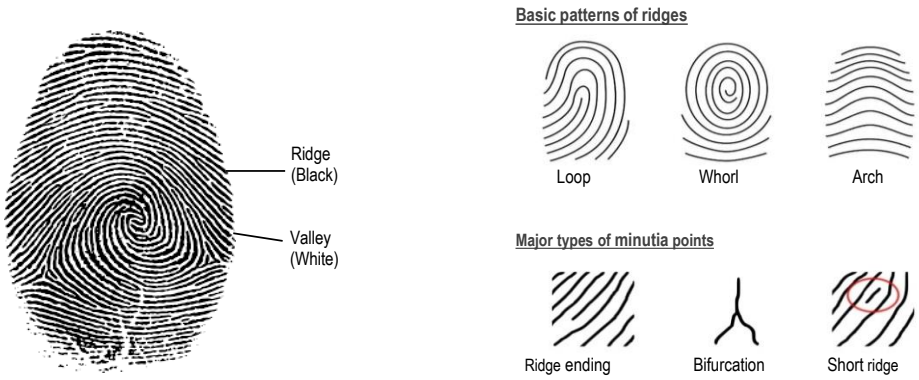
Uniqueness and permanence make FP an ideal solution for biometric authentication. FP recognition is a method to identify an individual by the ridges and valleys found on the surface of a human fingertip. Ridge patterns and minutia points form the uniqueness of a fingerprint, with 3 main ridge patterns of loops, whorls and arches accounting for roughly 60-65%, 30-35% and 5-10% of the total population, respectively. Minutia points of FP refer to discontinuities in ridge flows, and there are over 100 types of minutia points that are categorised, such as ridge ending, bifurcation and short ridge. In most cases to prove that 2 FP are identical, a match between around a dozen minutia points is needed.

Types of biometrics

Biometrics			
Visual	**Behavioural**	**Olfactory**	**Vein**
Ear (the shape of the ear)	Gait (walking style)	Odour	Vein recognition (finger or palm)
Eyes – Iris/retina recognition	Typing recognition		
Face recognition	Signature recognition (handwriting style)	**Auditory**	**Chemical**
Fingerprint recognition		Voice	DNA matching
Finger geometry recognition			
Hand geometry recognition			

Source: Biometrics Institute

The features of a fingerprint



Source: Cub Scout ideas, iNotes4you

The history of FP authentication

It's been nearly 50 years since the first automated FP identification system was invented

In ancient times, people were already using FP as a sign of confirmation in business contracts. The first systematic research of FP recognition can be traced back to 1892, when Francis Galton, an English statistician and eugenicist, published a book called *Finger Prints,* detailing his statistical model of FP analysis and identification. In the same year, an Argentinian chief police officer, Juan Vucetich, developed the first method to record the FP of individuals on file based on Galton's method. However, FP identification was not automated until 1969, when the Federal Bureau of Investigation (FBI) began its push to develop a system that could automate its FP identification processes. The initial method to record FP was an optical method, which was expensive at that time, so only the government adopted FP recognition until the late-1990s, when the first commercial FP authentication technology based on integrated capacitive sensors became available.

After 2 decades of FP sensors being applied in mobile phones, vendors are pushing UDFP for full-screen features

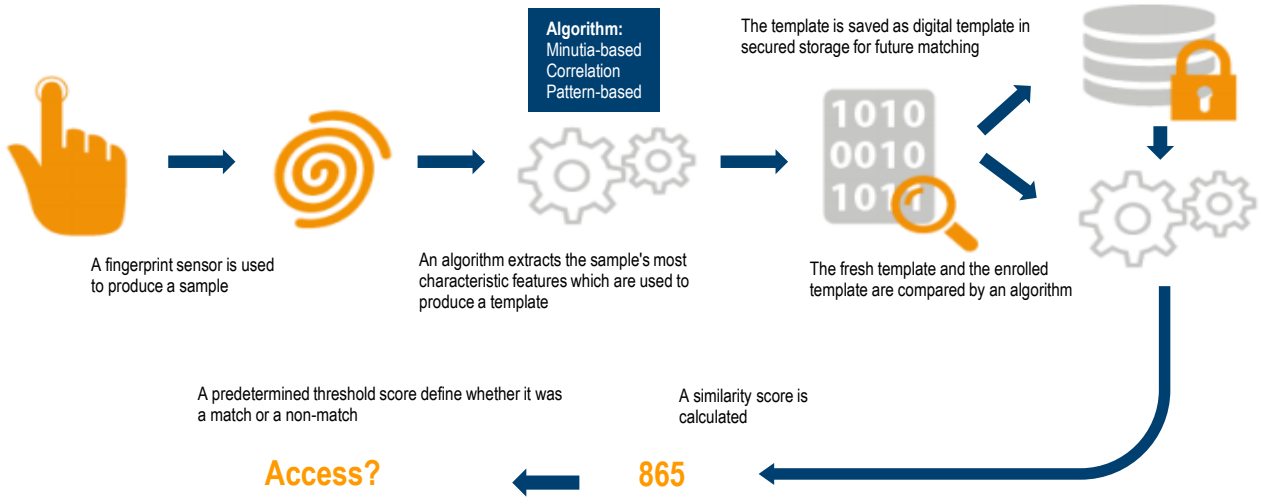
In 1998, the first mobile phone with an FP sensor was prototyped by Siemens. Some 13 years later, Motorola rolled out its first smartphone, the Atrix, which adopted the capacitive type of FP sensor. After Apple released its first smartphone in 2013 embedded with an FP sensor called Touch ID (iPhone 5S), FP sensors started to gain popularity in the smartphone market. To avoid Apple's patents which used a pressing-type method onto the home-button designed by AuthenTec (acquired by Apple in 2012), Android smartphone vendors used a swiping-type approach over scanners until 2014, when they switched to the pressing-type. In 2018, Vivo put out the first smartphone in the world with a UDFP sensor, named the X20 Plus UD. Since then, smartphone vendors have changed their phone specs, pushing UDFP solutions in order to accommodate the trend towards full-screen displays.

FP authentication process

2 key elements: sensor and algorithm

Two key elements for FP authentication are the sensor (hardware) and algorithm (software), which when combined, judge the matching of the FP. First, the sensor captures the FP image by optical, capacitive, ultrasonic or thermal methods. The image is encrypted to meet system requirements such as image enhancement, and then the algorithm extracts the distinguishing features of the FP and stores them as a digital template for the FP for future matching or compares them with the current template to identify or authenticate the user.

Fingerprint authentication process



Source: Precise Biometrics, Daiwa

Optimised integration for right FAR/FRR

Three types of algorithm methods are employed: 1) the minutia-point method, which compares the minutia points of the FP for identification/authentication, 2) the correlation method, which overlays 2 FP images with the same pixels to determine identity, and 3) the pattern method, which determines identity by comparing the basic patterns between the pre-stored template and the candidate. The keys to performance are the integration of the sensor and algorithm to optimise the footprint of the sensor module and recognition efficiency, represented by the false acceptance rate and false rejection rate (FAR/FRR).

Types of FP sensing methods

There are a variety of technological methods by which to capture FP images, including mechanical (ink deposition, pressure sensing and vibration damping), electrical (conductive, capacitive, radio-frequency imaging), optical, ultrasonic and thermal. As illustrated in the chart next page, we elaborate below on 4 methods commonly used in the tech space.

Capacitive

Capacitive type converts FP images from analogue to digital

A capacitive sensor uses a very small footprint of capacitor circuits to collect the detail of an FP. Due to the feature of storing an electrical charge, capacitors are used to track the ridges and valleys of an FP by connecting them to conductive plates on the surface of the scanner. When a finger is placed over the scanner, the ridges contacting the conductive plates lead to changes in the charge stored in the capacitor. These changes are tracked by an operational amplifier integrator circuit and then are recorded by an analogue-to-digital (A/D) converter. This digital data is then used for comparison of the authentication process. There are 2 types of capacitive FP sensing technology: active and passive. While Apple has adopted the active method, protected by its patents which are slated to expire in December 2020, on our market research, other smartphone FP vendors use the passive capacitive technology.

Optical

Optical type converts FP images from photonic to digital

The optical method is perhaps the earliest method of converting FP patterns into electronics for authentication. The idea is to capture the FP image via a CMOS image sensor (CIS) or a charge-coupled device (CCD) for comparison. When a finger touches the scanner, the sensor emits light signals to the fingertip for “picture shooting”. As different reflections between the ridges and valleys are produced, an image with darkness and brightness is created. The CIS or CCD can generate electrical signals in response to the light photons. The optical method is less reliable than others like ultrasonic and capacitive, since the image captured by this method is a 2D image, which means the sensor can be fooled by another 2D FP picture of sufficient resolution. So far only smartphones configured with OLED type screen displays use the optical solution, since the scanner requires a light source to illuminate the ridges of the finger.

Ultrasonic

Ultrasonic builds an FP image on differences in sound waves

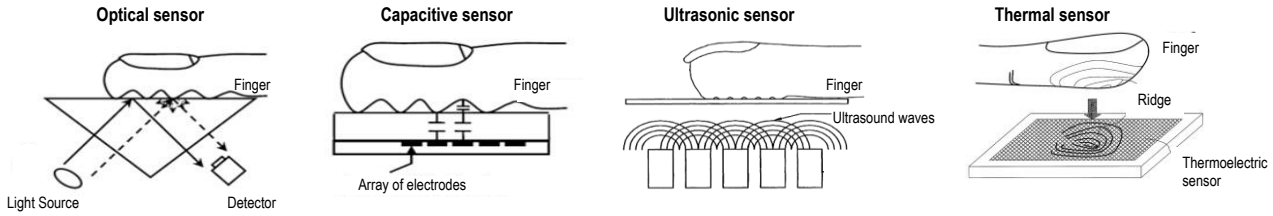
An ultrasonic sensor can construct a 3D image of FP based on differences in ultrasonic absorption or reflection between the ridges and valleys. The system consists of an ultrasonic transmitter and receiver by transmitting ultrasonic waves to the fingertip when a finger is placed over the scanner. Some of the waves are absorbed and others bounce back depending on the ridges and valleys of the fingertip. Based on the returning ultrasonic waves at different points on the scanner, an FP image can be constructed.

Thermal

Thermal type captures an FP image by detecting temperature differences

This method uses a 2D thermoelectric sensor array to capture an FP image based on the thermal image related to the ridges and valleys on the finger. The concept is similar to using the body temperature of a human being as a stimulation source for biometrics. When a finger contacts the thermoelectric sensor, a temperature difference is produced between the ridge of the fingertip and the sensor. Then the temperature gradient is converted into an electrical signal. The FP sensor is formed by a plurality of thermoelectric sensors arranged in a 2D array so to obtain the electrical signal-output of the FP ridge profile.

Types of fingerprint sensor



Source: Google Patent

Rising adoption of UDFP

UDFP is rising thanks to the push of full-screen smartphones

Capacitive FP sensors have been widely used in the smartphone market since Apple adopted this technology due to the technology's low cost and relative maturity. However, in view of the trend towards full-screen handsets, smartphone vendors are placing sensors under the display instead of combining them with the home button, which has spurred the adoption of UDFP since 2018. Since low penetrability (typically less than 200μm in thickness) means capacitive sensors are not viable for use in full-screen smartphones, some vendors are working on offering alternatives that put the capacitive sensor on the back or edge of a smartphone, but user experience is a concern.

Two technologies are employed for UDFP, in terms of sensor type: optical and ultrasonic. Whereas both are currently used only for OLED displays, FP solution providers such as Goodix are developing in-display sensors for smartphones with LCD displays too, with the goal of expanding the addressable market. The table below illustrates the pros and cons of the 2 technologies in comparison with the traditional capacitive type.

FP technology comparison: optical, ultrasonic and capacitive

	Capacitive	Optical	Ultrasonic
Under-display	Not yet	Yes	Yes
Cost	Low	Moderate	High
Penetrability	Low	Moderate	High
Resist contaminant	No	No	Yes
Display	OLED/ TFT LCD	Rigid/flexible OLED	Flexible OLED
Image	2D	2D	3D
Power consumption	Low	Low	High
Accuracy	Moderate	Low	High
Response time	Short	Short	Long
Production	Easy	Moderate	Difficult

Source: Daiwa

Appendix 2: glossary of terms

AI surveillance. A type of surveillance method that deploys artificial intelligence (AI) technology. It can automatically collect and analyse data, as well as provide real-time monitoring without human operation. This is because AI-enabled surveillance uses algorithms to do intelligent analysis, has higher accuracy and is more efficient than traditional surveillance – an example of BigData analytics using AI technology.

Biometric authentication. A type of authentication method that uses biological characteristics as passcodes, common in the daily lives of human beings, such as unlocking a phone by face or fingerprint recognition, or withdrawing money from an ATM by vein recognition. There is a wide range of biometrics, from visual recognition such as face or fingerprint to the characteristics which cannot be observed directly, like vein recognition and DNA matching.

Capacitive touch IC. A type of touch IC controller that controls and monitors a touch event by measuring the change in electrostatic capacitance produced between an electrode and a fingertip. A measurement circuit converts the change in the capacitance into a trigger signal when it detects it, and this signal is further processed by other chips inside the machine for necessary action to facilitate the user's needs.

A charge-coupled device (CCD) is a light-sensitive IC etched onto a silicon surface that can convert photons into electrons. A CCD contains 2 main parts: colour filter and pixel array. Whereas the colour filter is used to filter out wavelengths of unwanted colours, allowing only certain colours of light to pass through, the pixel array functions on the principle of the photoelectric effect. A capacitor in the pixel array captures the intensity data of the light passing through by accumulating an electric charge proportional to the light intensity at that location and then transfers the contents to its neighbour. The last capacitor in the array dumps its charge into a charge amplifier, which converts the charge into a voltage before outputting it to an external circuit board for further processes.

A complementary metal oxide semiconductor (CMOS) is a type of transistor that produces either a positive MOS (PMOS) or negative MOS (NMOS) charge at any given time. As one of the circuit types is always turned off, a CMOS chip only draws power when switching between on and off mode. Thus, CMOS chips run efficiently, drawing much less power than chips that use just one type of transistor. CMOS process technology is widely used for a variety of logic and mixed-signal IC production. Intel, TSMC, Samsung Electronics and Texas Instruments are some of the leading players in the global CMOS manufacturing space.

A CMOS image sensor is a type of image sensor that senses the image of an object by projecting lights, and then converts the photons to electrons for digital processing inside an electronic device such as a digital camera. A CMOS image sensor module is composed of 4 main parts: pixel array, colour filter, A/DC converter and digital controller. The pixel array contains minute light-capturing pixel sensor ICs that capture the intensity of the light of specific wavelengths which is filtered by the colour filters, and then convert the sensitivity of the light to voltage signals. Since these signals are analogue, the A/DC converter is responsible for converting the voltage signals from the pixel sensor array into digital signals for further processes inside the box of the device. The digital controller governs the pixel array to ensure synchronisation among all pixels.

Deoxyribonucleic acid (DNA) is the name given to the hereditary materials in almost all organisms and contains the instructions necessary to build and maintain an organism. DNA is a long, double-stranded, helical module made up of molecules called deoxyribonucleotides, which are composed of a molecule of the 5-carbon sugar deoxyribose, a nitrogenous base, and a phosphate group. There are 4 types of

nitrogenous bases: adenine (A), thymine (T), guanine (G) and cytosine (C). The DNA's instructions are determined by the order of these nitrogenous bases.
False acceptance rate/false rejection rate. The FAR measures the likelihood that an unauthorised user is incorrectly accepted by a biometric security system, while the FRR measures the likelihood that an authorised user is incorrectly rejected by the biometric security system.

Light detection and ranging (LiDAR) is a remote sensing method that measures distance to a target by illuminating that target, typically with a low-power, eye-safe pulsing laser working in conjunction with a camera. The associated software, or algorithm, then calculates the time it takes for the laser to reflect back from the target in order to measure the right distance – a similar mechanism to the time-of-flight (ToF) method.

An organic light emitting diode (OLED) is composed by stacking thin-film layers made from organic semiconductor materials, where the layers are between 2 electrodes (cathode and anode) on a transparent substrate. Unlike a liquid crystal display (LCD), a display-screen configured with OLED technology is self-emissive when electrical current travels through the organic materials.

Structural light (SL) is one type of optical sensing & imaging technology that captures the 3-dimensional topography of a surface by projecting a specific pattern of light onto the surface. The specific pattern is distorted by the surface features of the target object when the camera views the pattern from a different perspective. Then, the surface topography of the target object can be reconstructed by the direction and size of the pattern distortions.

Time of flight (ToF) is one type of optical sensing & imaging technology that measures the distance between an object and a sensor based on the time taken by a light signal that is emitted from the source and bounce back from the object. ToF can be utilised by a range of applications in 2D/3D format, such as proximity sensing, detecting and ranging, as well as 3D imaging through generation of "point cloud".

A vertical cavity surface emitting laser (VCSEL) is a type of laser diode based on compound semiconductor process technology that emits a highly efficient optical beam vertically from its top surface. Another type of laser diode emits an optical beam from the edge of the diode, and is called an edge emitting laser (EEL). The vertical cavity structure of the VCSEL allows engineers to build a large number of lasers next to each other to form 2D arrays.

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Disclosure of investment ratings

Rating	Percentage of total
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Source: Daiwa

Notes: data is for single-branded Daiwa research in Asia (ex Japan) and correct as of 30 June 2019.
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