DOLPHIN INTEGRATION
The Enabler of Energy-Efficient Systems-on-Chip

Addressing the Energy Efficiency Challenges of IoT end points

D&R IP-SoC Days, Grenoble – December 5th 2018

Pierre Gazull – Business Development & Product Marketing Manager, IoT

ABOUT US

- Since 1985

- HQ in Grenoble, France
- Subsidiaries in Canada & Israel

- About 150 highly qualified engineers

- Strong leadership in ultra-low power and energy-efficient SoC & IP design

> 200 Silicon IPs available across multiple nodes and foundries

> 500 customers worldwide

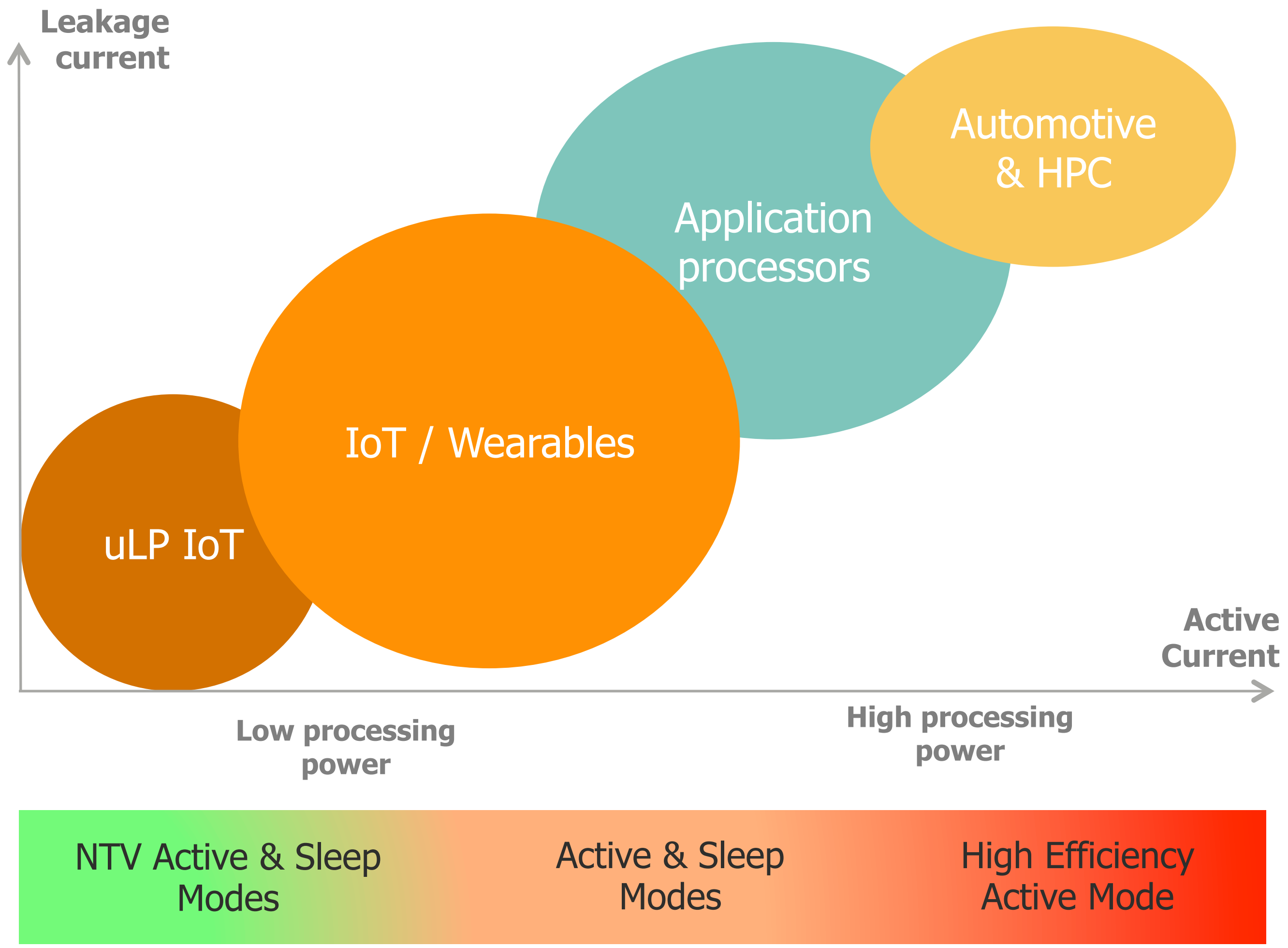
OUR STRATEGIC POSITIONING & DELIVERABLES

Bridging the Complexity Gap to Design Energy-Efficient SoCs

- Power Efficient **Silicon IPs Platform**
- Power Network Exploration & Design **Tools**
- ASIC Design & Supply **Services**

Addressing Growing Markets

- Energy efficient products make better products
  - → Cheaper package
  - → Better BoM costs
  - → Higher reliability
  - → Longer battery operation
  - → Smaller form factor



Energy efficiency challenges

Breakthrough Power Management IPs Portfolio

SoC Power Network Exploration

Example on NB-IoT

IoT Devices Mission Profiles

Smart City IoT Devices

- Low-cost and small form factor
- Connect to the gateway or direct to cloud
- Mesh or Cellular (NB-IoT)
- **Battery powered in remote locations with 10 years operation**

Use cases

Environment monitors, utilities metering, smart lighting, asset tracking,

Consumer IoT Devices

- Connected device balancing performance & power
- Local data or audio processing capabilities
- Integrated BLE
- **Rechargeable battery powered**

Use cases

asset monitoring, wearables,

Edge Computing IoT devices

- IoT end points with high levels of data processing and context-based decision making such as AI at the edge
- Integrated BLE, WiFi or Cellular (NB-IoT or LTE-M)
- **Wall and battery powered**

Uses cases

Smart Home & Industrial gateway, surveillance cameras,

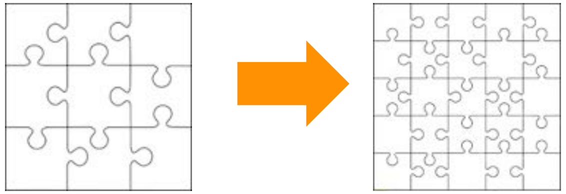
Why do We Need to Reduce Power Consumption ?

Market trends for battery-operated devices : Get the highest SoC energy efficiency

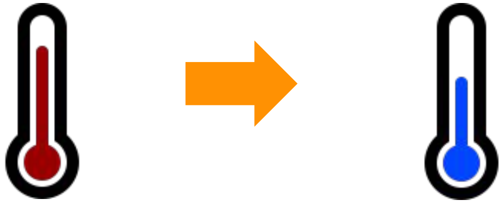
Replacement frequency

Battery Size

SoC Complexity



Heat dissipation



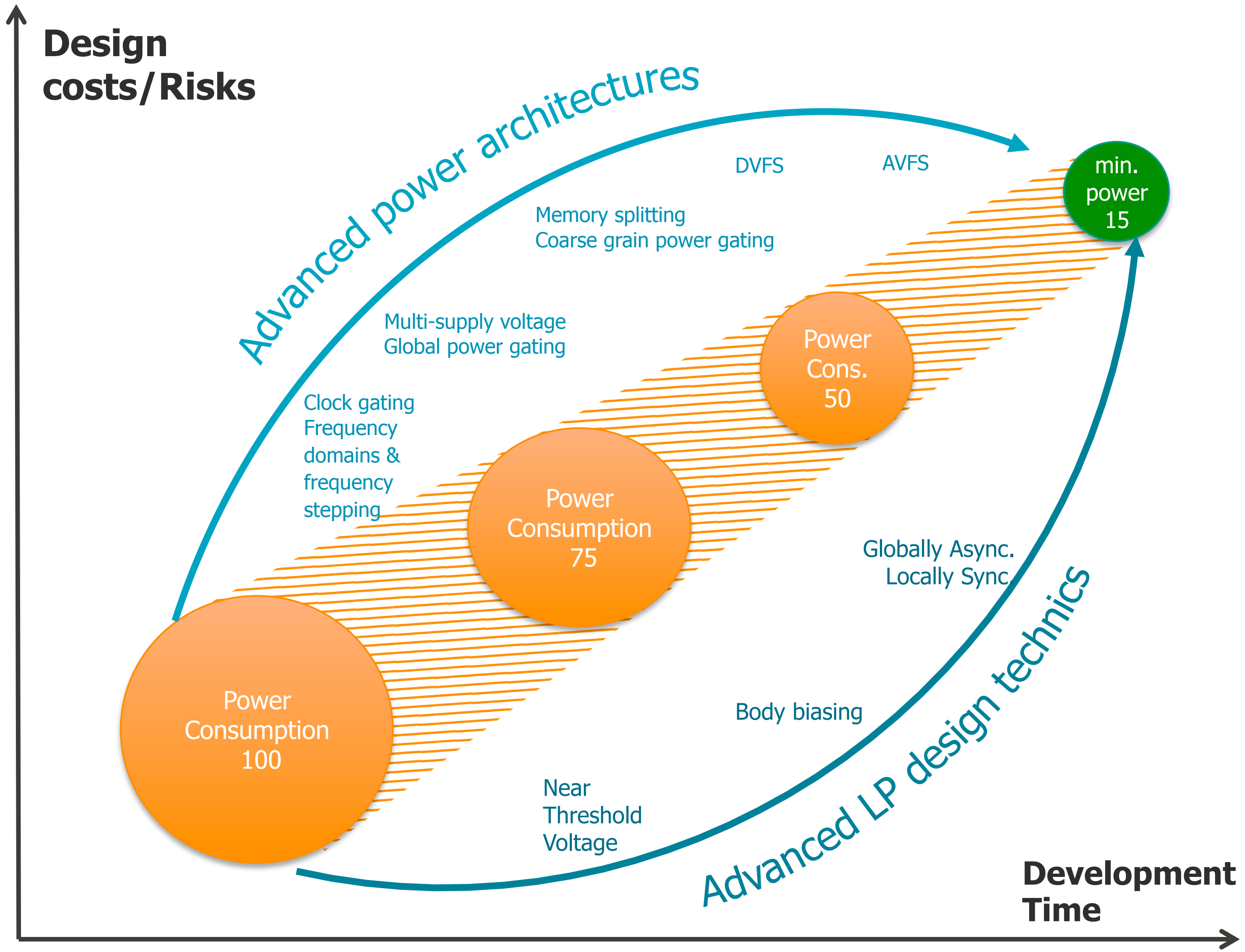
Challenges for designing Energy Efficient SoCs

How to speed-up the power architecture exploration and selection?

How to leverage on IP power modes and adopt more complex power architectures ?
How to streamline this adoption?

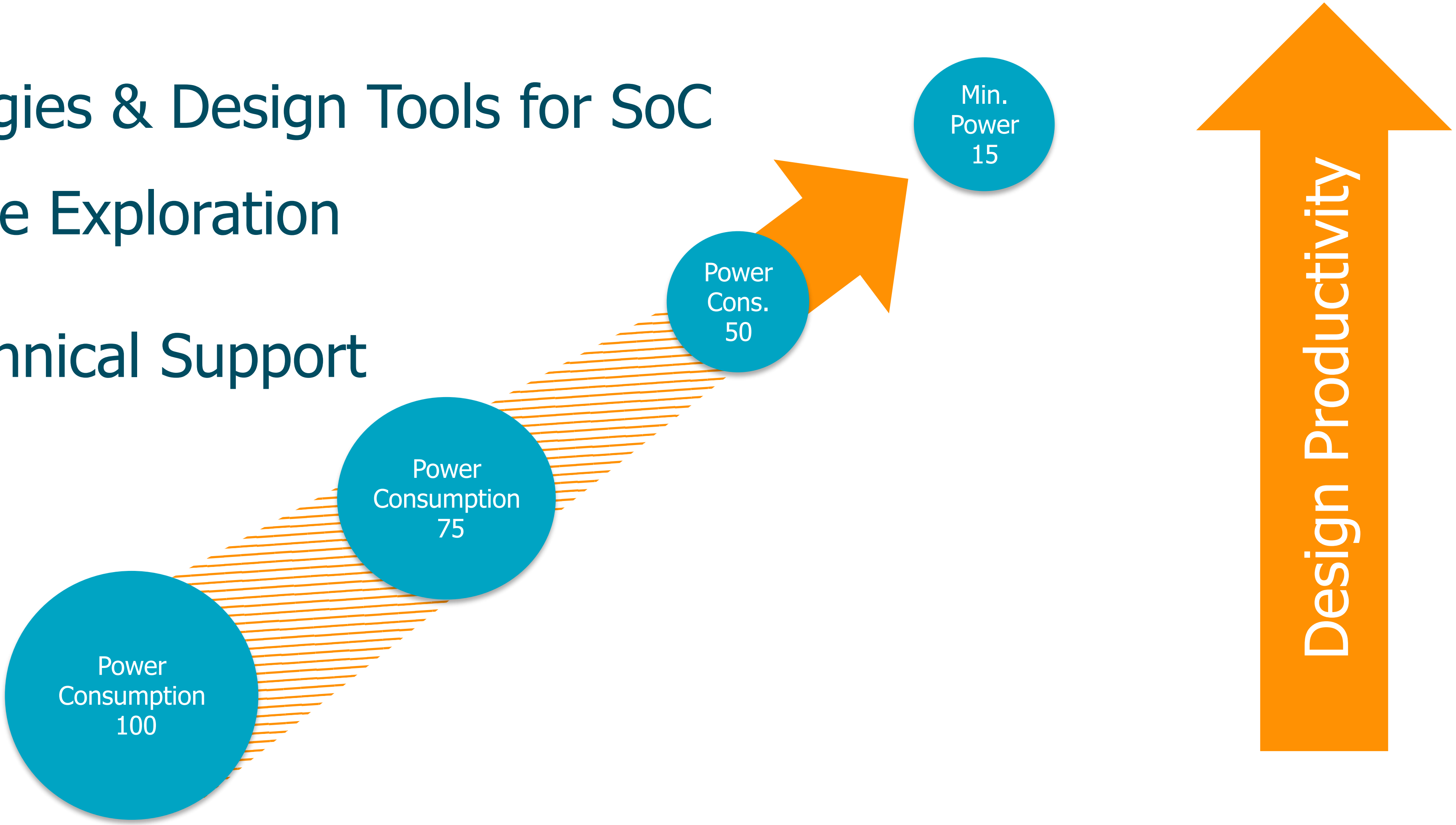
How to reduce design, fabrication and BoM costs ?

How to safely speed-up the design of complex and noise-sensitive Mixed-Signal SoCs ?



OUR DELIVERABLES

- Power Managements IPs Portfolio
- Methodologies & Design Tools for SoC
  Architecture Exploration
- Expert Technical Support



AGENDA

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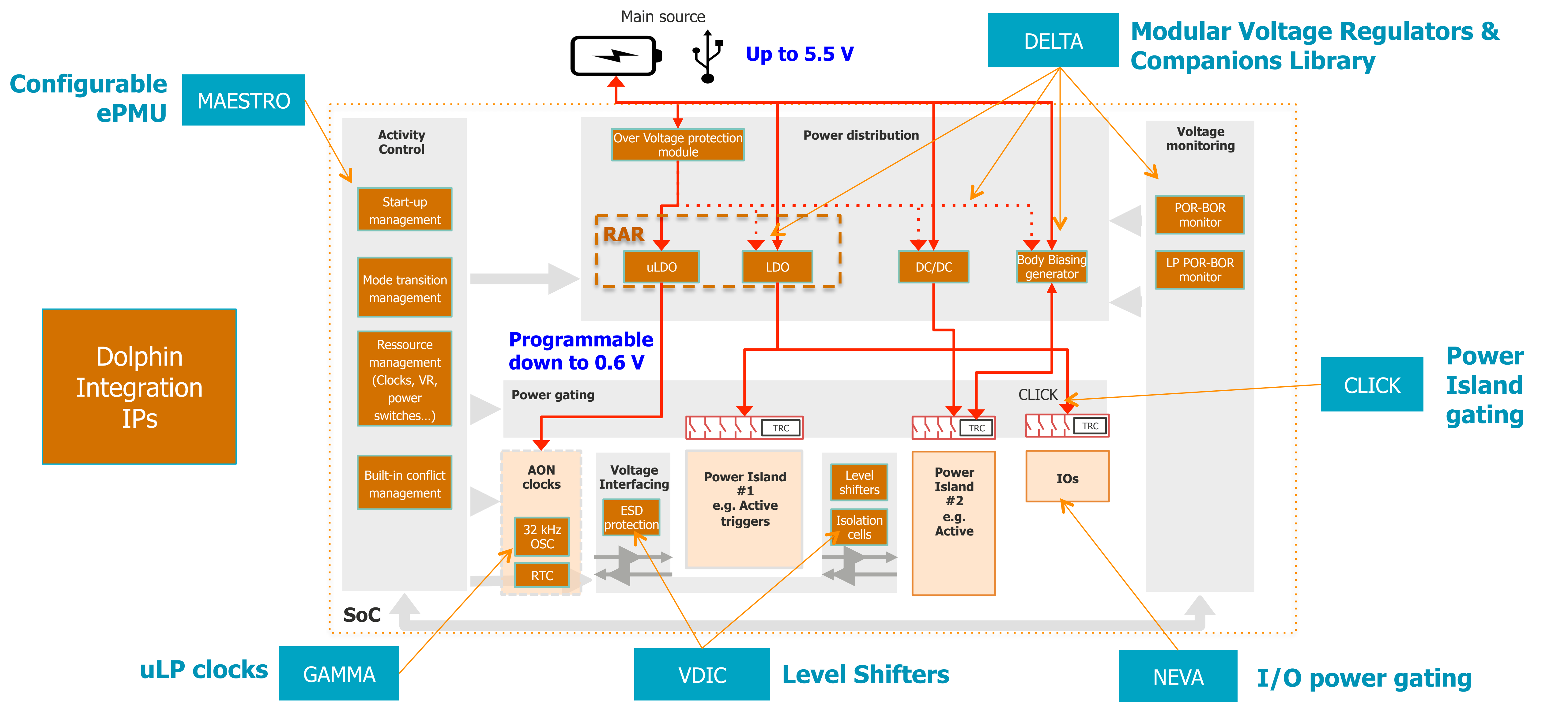
A Complete Power Management IPs Portfolio



Power Management IPs Highlights

Embedded Power Management Unit
MAESTRO

- Configurability
- Resource conflict management
- Boot-up sequence management
- Mode transition sequence management
- Native DVFS support

Power Regulation Network
DELTA

Library of **LDO or DC/DC** Voltage Regulators
- Low Quiescent **< 150 nA**
- Low Leakage
- Low Noise **< 20 µV RMS**
- High efficiency **> 95%**

Modular

Programmable output voltage **from 0.4 V to 3.3 V**

Input voltage **up to 5.5 V** operations

+

Power Gating Controller for Island & IO
CLICK & NEVA

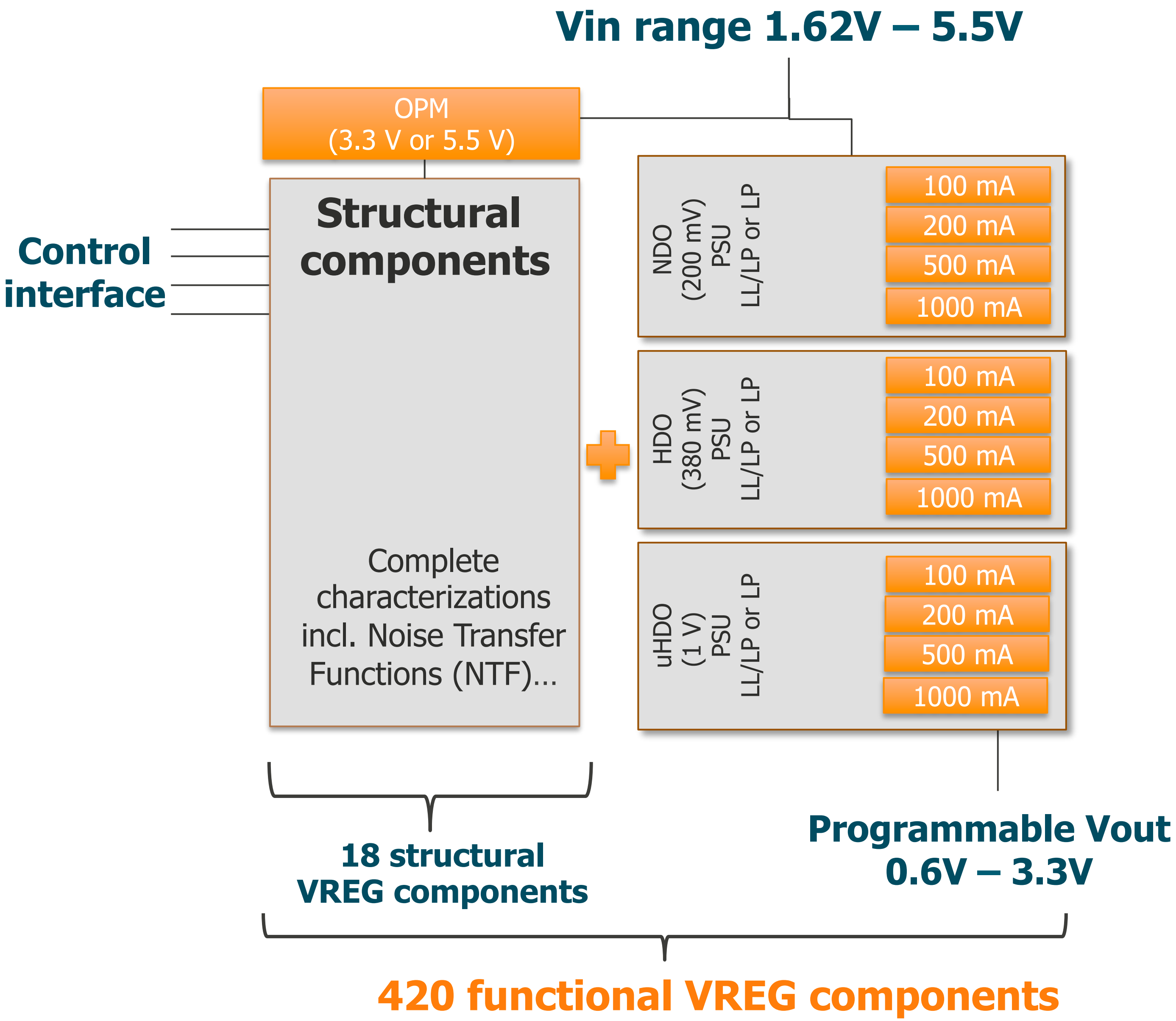
- Register programmable even after tape-out
- In-Rush current management
- Easy implementation
- Single-pass implementation

+

Clock Network
GAMMA

- Low Frequency **32 kHz**
- Ultra Low power **< 60 nA**
- Fast wake up and high accuracy
- RC-based XTAL-based

Voltage Regulators Built upon reusable and common IP components



- LDO
- Low-Noise LDO
- Ultra-Low Quiescent LDO
- Fast Transient LDO
- uLDO/DC-DC Composite Regulator
- LDO/uLDO Composite Regulator
- High-Efifciency DC-DC Regulator
- High Current DC-DC Regulator

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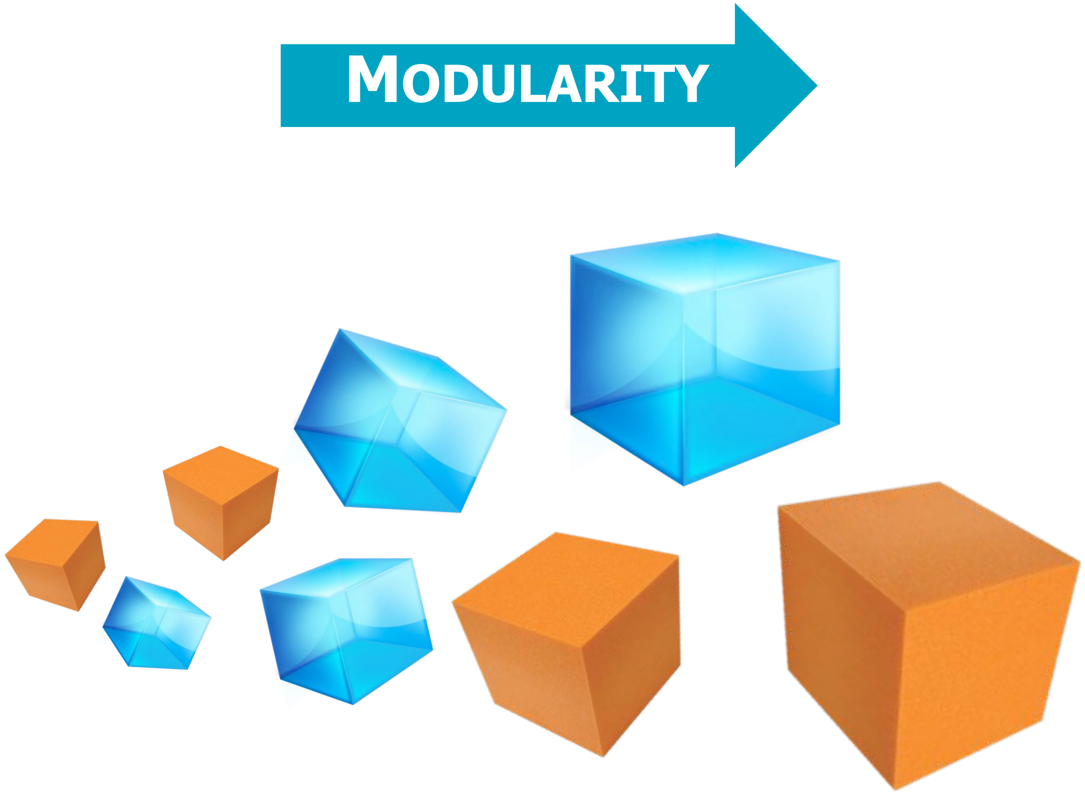
XTAL-based

FROM CUSTOM PMU TO CONFIGURABLE ePMU

FULL CUSTOM

Complex elaboration with unexpected oversights



MAESTRO

Hierarchical elaboration using generic and configurable modules

MAESTRO ePMU GENERATOR

Defined by SoC Architect

SoC specifications and functionalities

Power Island Mode Table

	AON	Island #1	Island #2	Island #3	Island #4
SoC Functional operating mode	ACU RTC	ADC comp WIC /GPIO	CPU Data SRAM	DMA / SPI I2C / WDT	ADC Data SRAM
Active	0.7 V 32 KHz Active	0.7 V 32 KHz Active	1.1 V 32 MHz Active	1.1 V 32 MHz Active	1.1 V 32 MHz Active
ADC monitor	0.7 V 32 KHz Active	0.7 V 32 KHz Active	0.9 V 32 MHz Active	0.9 V Retention	0.9 V 4 MHz Active
Sleep	0.7 V 32 KHz Active	0.7 V 32 KHz Active	0.9 V Retention	0.9 V Retention	0.9 V Retention
OFF	0.7 V 32 KHz Active	OFF	OFF	OFF	OFF

Mode transition sequences

Maestro ePMU RTL

Maestro SW drivers

Maestro core
- Sits in the AON domain

Core controller
- Handles register programming, power-up sequence and mode change sequences

Event handler
- Manages events to execute mode change sequence automatically

Resource controller
- Arbitration of island controller requests
- Voltage settings, voltage regulator modes, clocks

Island controller
- Split between AON and switchable domains
- Power domain states, isolation cells, in-rush current setting, wake-up time
- Request to resource controllers and power switch controller

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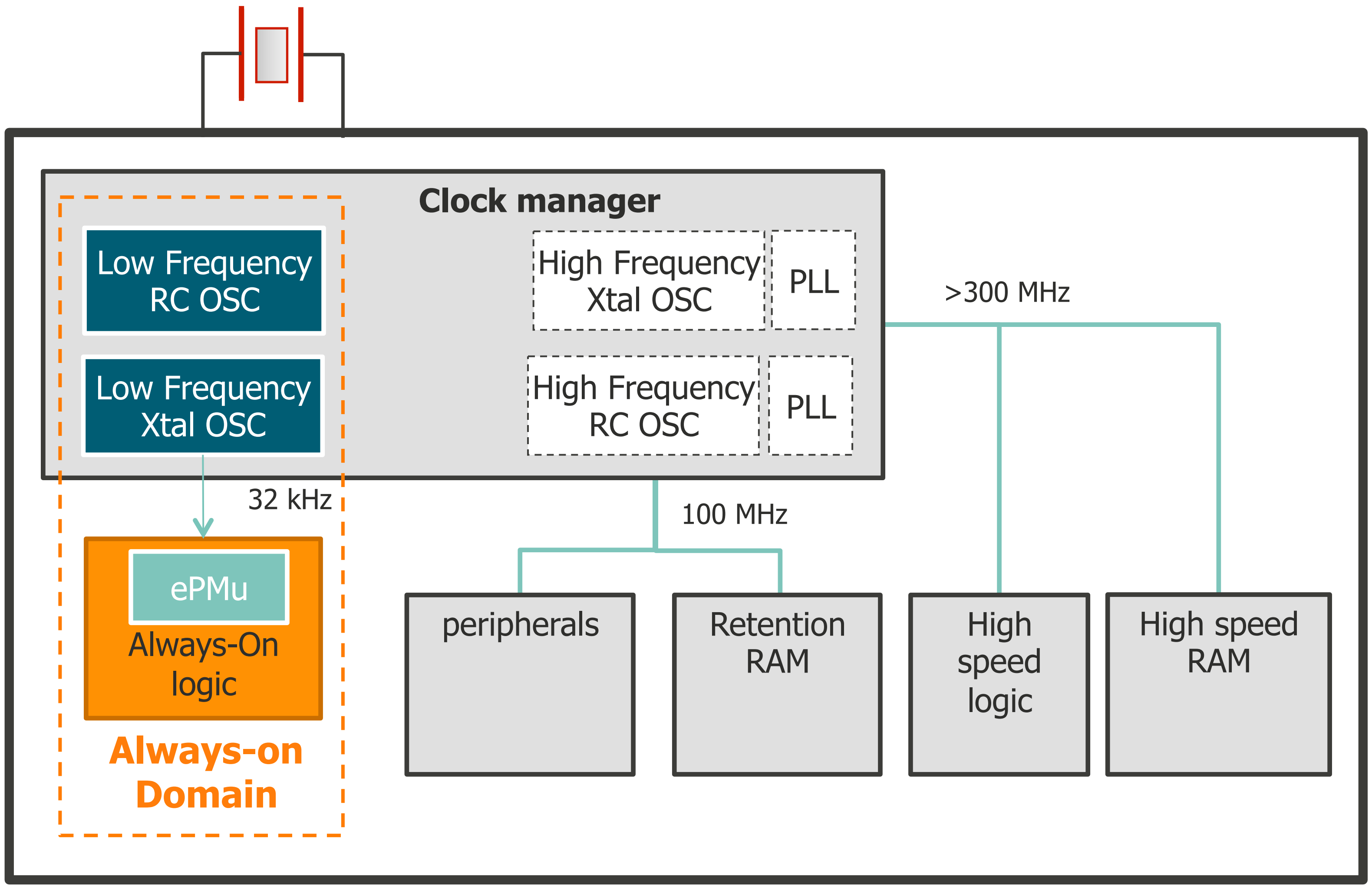
Clock Network in an SoC

Low frequency oscillators

- Count the time during sleep modes
- < 32 kHz
- In AON domain



High frequency oscillators:

- >1 MHz
- For a use in active mode

Our offering targets **low frequency oscillators** to optimize the power consumption of the Always-on domain

OUR OSCILLATORS FOR ALWAYS-ON DOMAIN

Oscillators	RC	XTAL
Frequency	32 kHz	32.768 kHz
Input voltage range	0.49 – 1.21 V	0.49 – 1.21 V
Power consumption	**~ 70 nA**	**~ 50 nA**
BoM Cost	**No external component**	External quartz needed
Accuracy	Lower accuracy and stability +/- 5 % after trimming	**Very precise and stable** over a wide temperature range +/- 0.05 % without capacitor Could reach +/- 0.005 % with external capacitors
Start-up Time	**Fast startup time** ~200 µs	Longer start-up time ~400 ms
Frequency	programmable	Not programmable
Silicon area	~ 0.040 mm^2	~ 0.042 mm^2
Target Applications	**Frequent awakenings**	**High accuracy**

Note : Performances data for 40 nm and 55 nm

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Energy efficiency challenges

Breakthrough Power Management IPs Portfolio

SoC Power Network Exploration

Example on NB-IoT

SAVE THE DATE

D&R IP-SoC Days Grenoble

Dec
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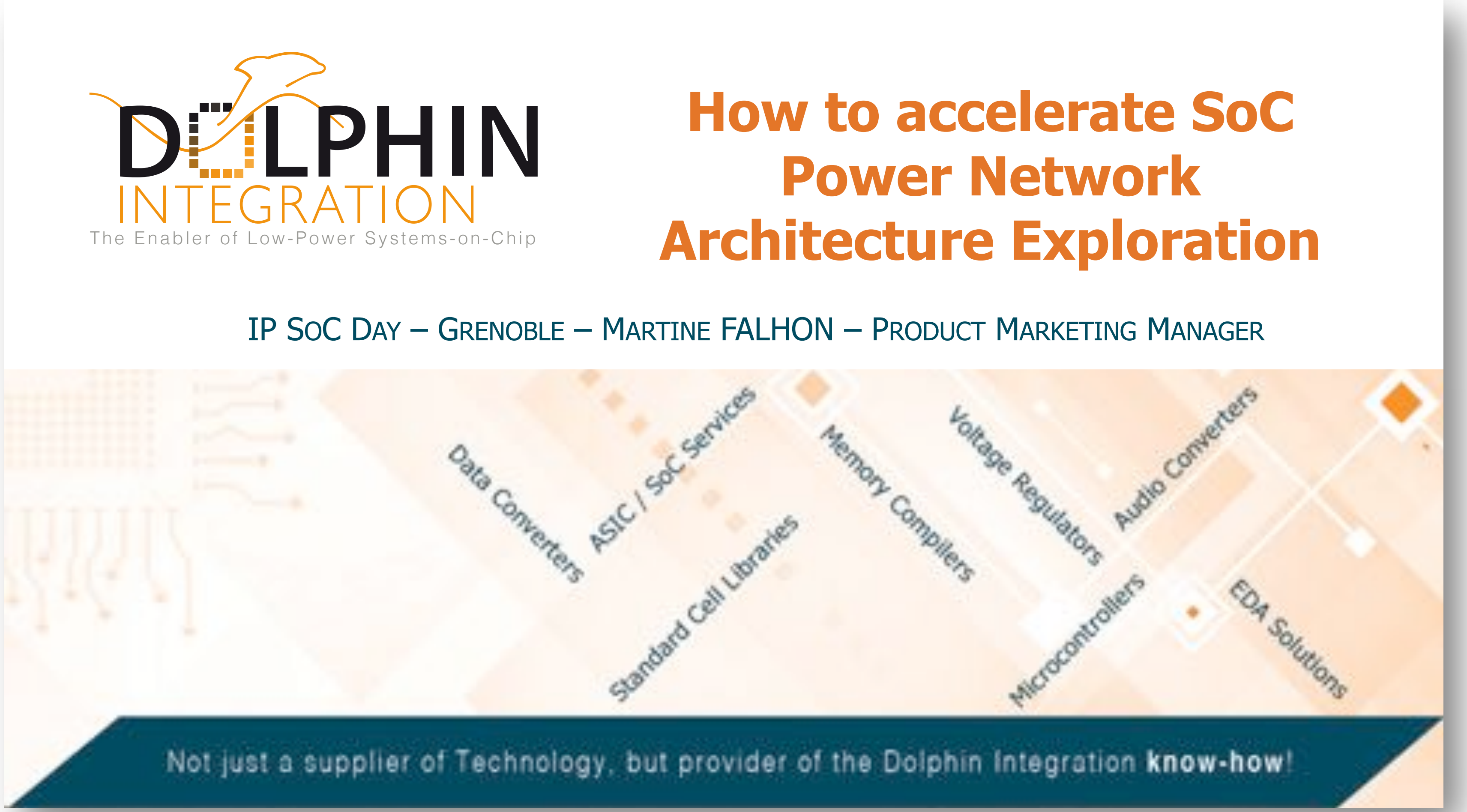

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NB-IoT Application Requirements

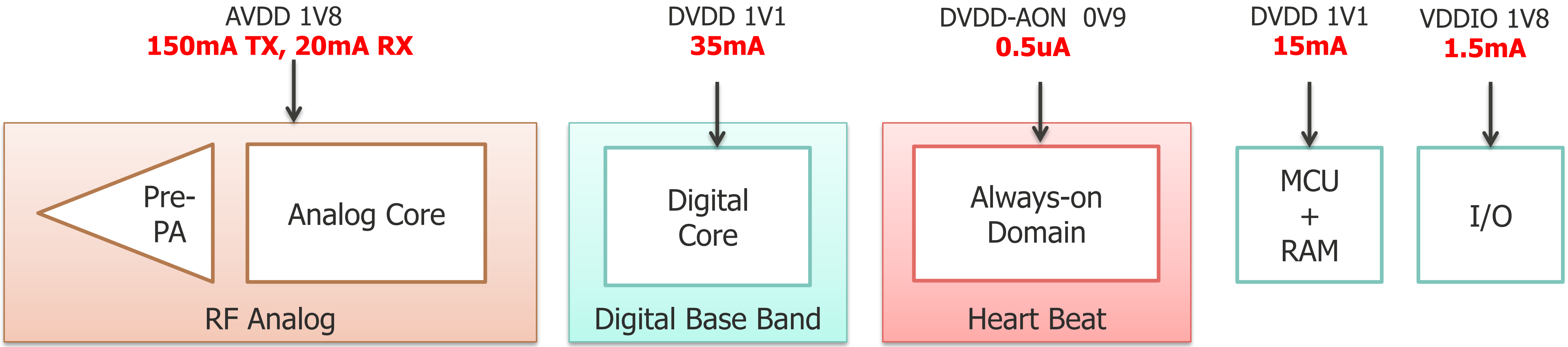
Battery

VBAT 2.7 - 5.5V

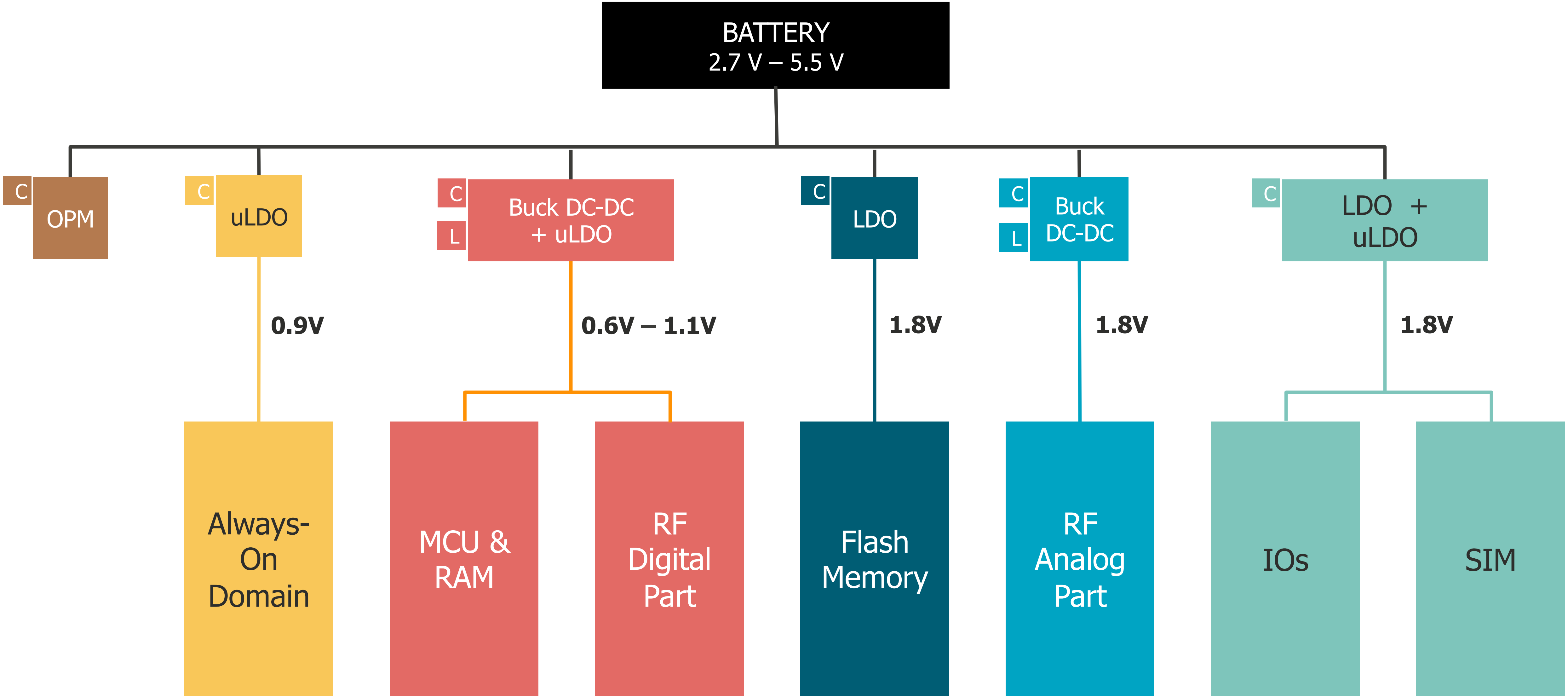
Activity Scenarios

- RF transmit mode: **3 s/day**
- RF receive mode: **12 s/day**
- Compute mode (RF off): **30 s/day**
- Deep sleep mode: **Rest of the day (99.99%)**
- **Battery autonomy: 10 years**

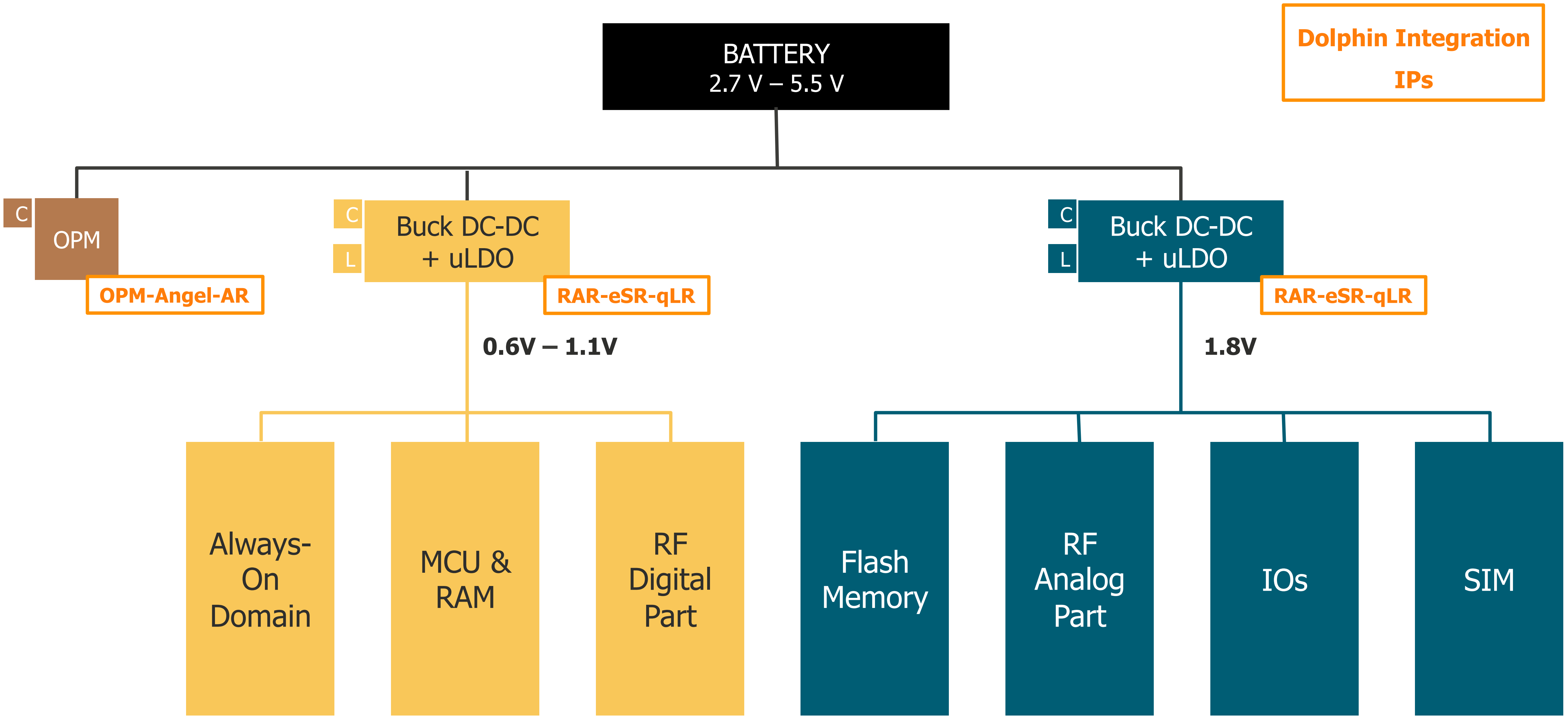
Power island load specifications



NB-IoT Architecture #1

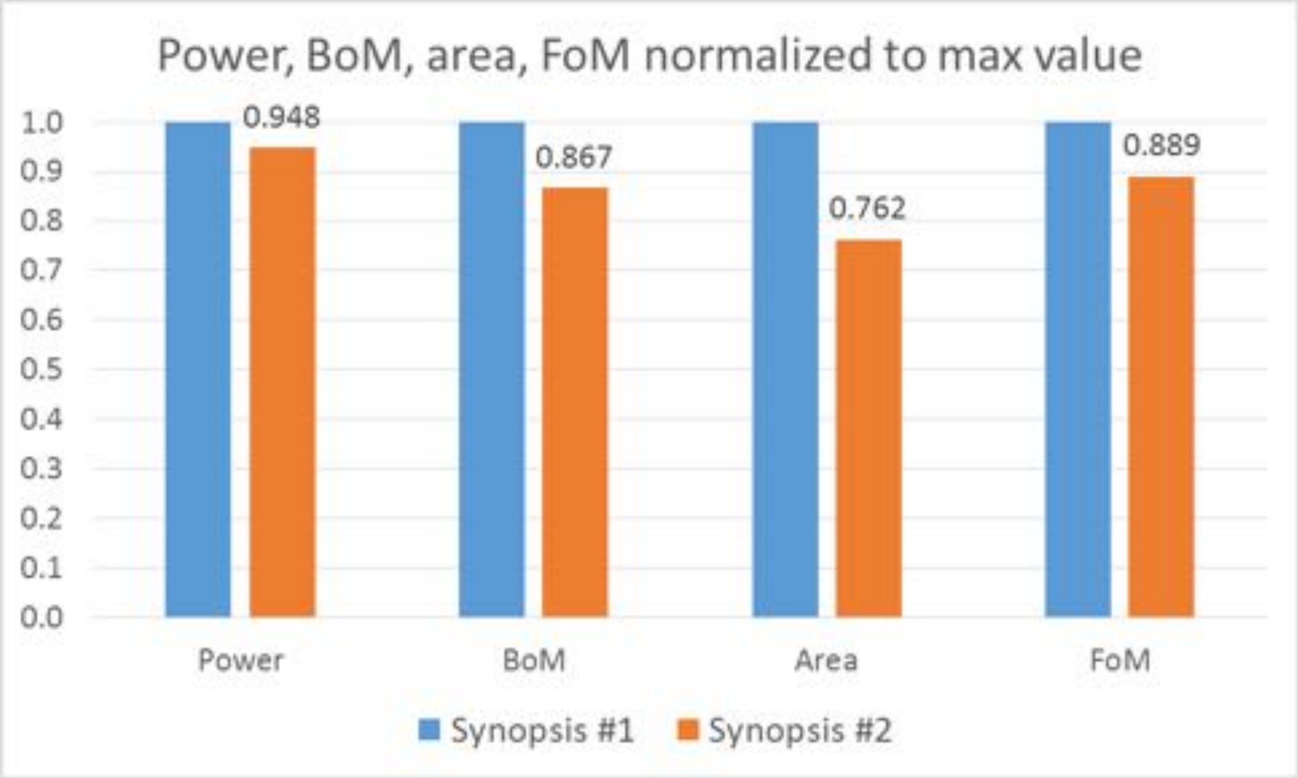


NB-IoT Architecture #2 : Optimization with Power Architect



ARCHITECTURE SELECTION WITH POWER ARCHITECT

	Current at battery source (A)					Relative contribution of each mode based on activity cycle				BoM	BoM	Area of VR	FoM	FoM, normalized	Lifetime @ 1000 mAh	Battery size needed for 10-year operation
	Average at battery source	RF transmit	RF receipt	StandBy mode	Processing mode	RF Tx	RF Rx	StandBy mode	Processing mode	count	(weighted)	(mm2)			(years)	lifetime (mAh)
Synopsis #1	12,09E-6	88,75E-3	33,69E-3	2,24E-6	6,02E-3	25,5%	38,7%	18,5%	17,3%	2L, 5C	30	2,962	1,000	1,124	9,441	1 059
Synopsis #2	11,46E-6	113,69E-3	26,69E-3	2,08E-6	4,97E-3	34,4%	32,3%	18,1%	15,1%	2L, 3C	26	2,258	0,889	1,000	9,960	1 004



Silicon Area is reduced by ~ 25%

& BoM is reduced by ~ 15%

Without degrading battery lifetime

KEY TAKE AWAYS

- Energy-efficient SoCs are mandatory to reach the IoT market requirements in terms of battery autonomy
- Dolphin provides a comprehensive Power Management IPs platform to speed-up the design of energy-efficient SoCs
  - → Consistent, modular, standardized Power Management IPs Portfolio
  - → Customer configurable ePMU for easy and safe control of the SoC power modes
  - → Design Tools for quickly exploring and deciding on the most optimal on-chip Power Regulation Network

thank you
danke
謝謝
ngiyabonga
teşekkür ederim
спасибо
dank je
gracias
tapadh leat
bedankt
hvala
mauruuru
mochchakkeram
dziękuję
go raibh maith agat
obrigado
sukriya
kop khun krap
arigato
takk
dakujem
grazie
мерси
terima kasih
감사합니다
merci