Oberon – M2M IoT Platform
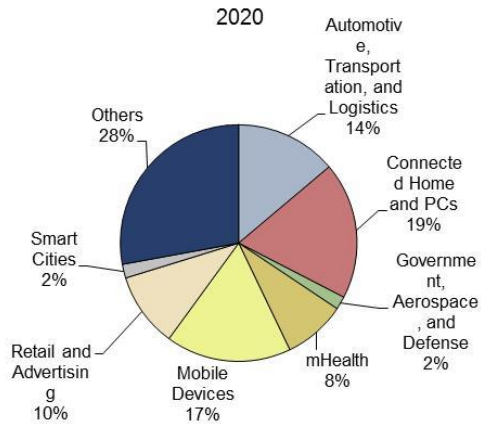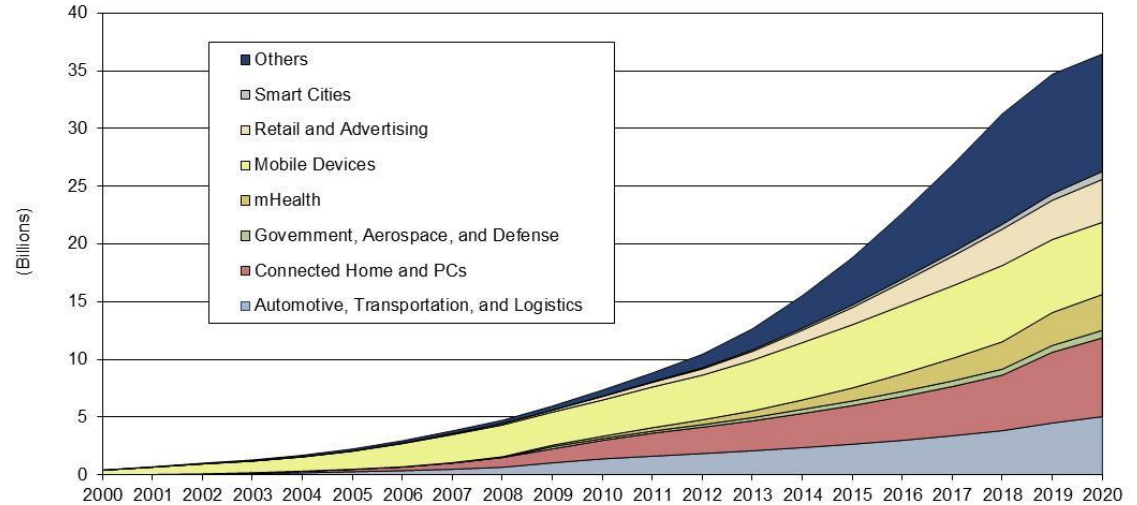
JAN 2016

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Contents

- **Iot Segments and Definitions**
- **Targeted Use Cases for IoT**
- **Oberon targeted use cases**
- **IoT Differentiators**
  - IoT Power Management
  - IoT Security
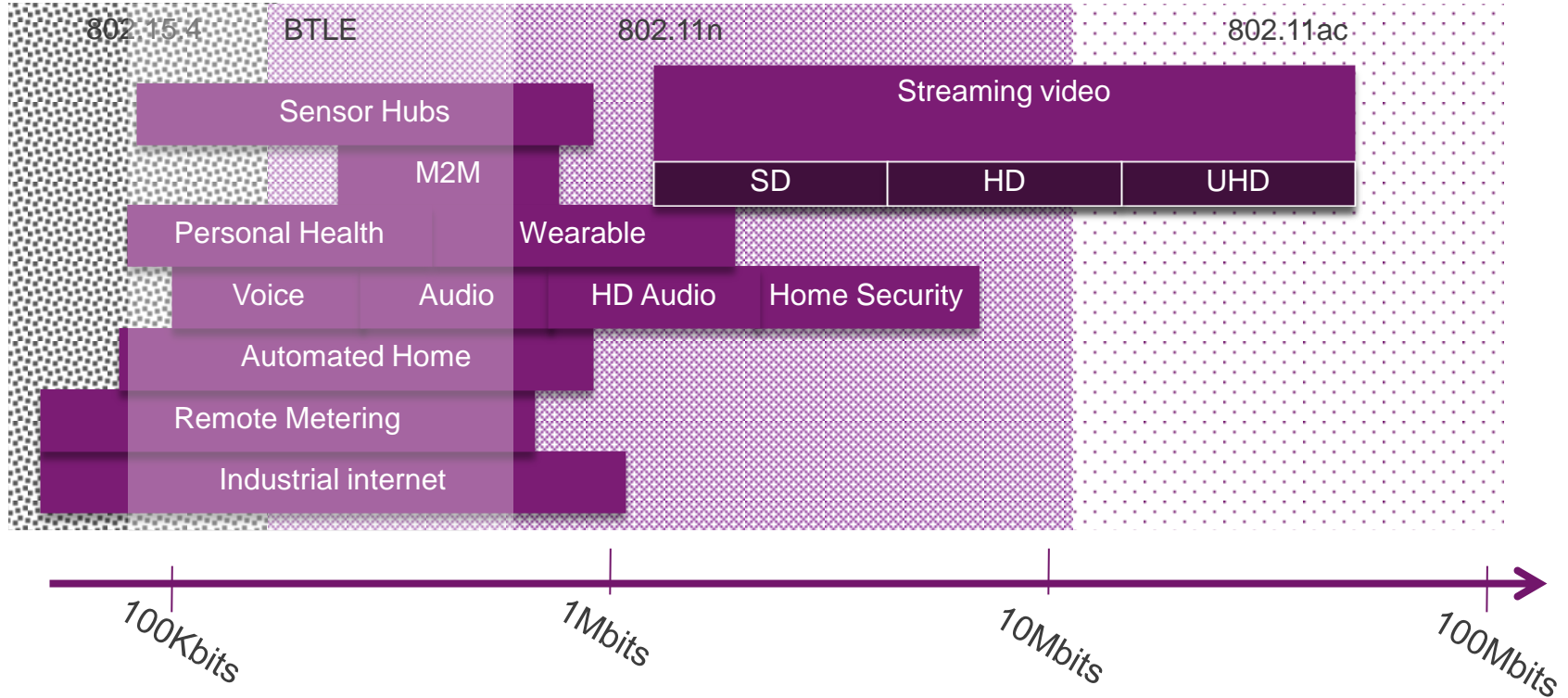 - Integrated Connectivity
  - Software
- **Schedule**

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IoT Market Definition – End Application Segments

2020

- Automotive, Transportation, and Logistics 14%
- Connected Home and PCs 19%
- Government, Aerospace, and Defense 2%
- mHealth 8%
- Mobile Devices 17%
- Retail and Advertising 10%
- Smart Cities 2%
- Others 28%

Legend:
- Others
- Smart Cities
- Retail and Advertising
- Mobile Devices
- mHealth
- Government, Aerospace, and Defense
- Connected Home and PCs
- Automotive, Transportation, and Logistics

(Billions)

Source: ABI, Nov. 2013

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IOT Application by Comms data rate requirements

802.15.4　　　BTLE　　　802.11n　　　802.11ac

Sensor Hubs

M2M

Streaming video

SD　　HD　　UHD

Personal Health　　Wearable

Voice　　Audio　　HD Audio　　Home Security

Automated Home

Remote Metering

Industrial internet

100Kbits　　1Mbits　　10Mbits　　100Mbits

Majority of IOT applications handled by BT, 802.15.4, and 802.11n

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IoT Use Cases

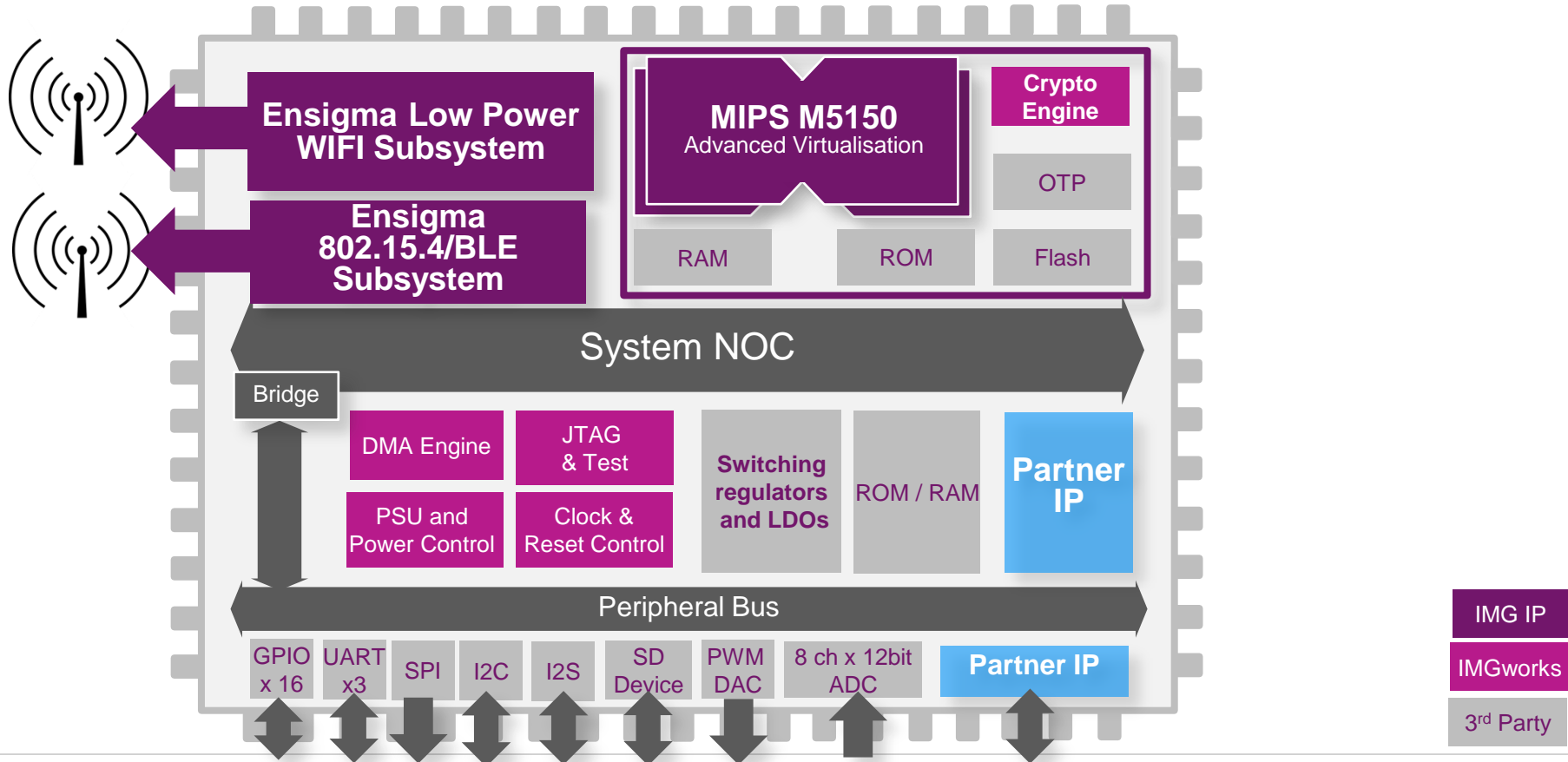|	IoT (M2M DATA) (Oberon)	IoT (Audio) (Hyperion)	IoT (video/camera) (Triton)
Device example	Personal health; Sensor Hubs; Smart home Energy management.	Wireless audio	Chromecast Connected camera Video analytics
CPU performance	< 250 DMIPs	300 – 800 DMIPS	2000 – 5000DMIPS
OS requirement	RTOS or No OS	Linux/Android or RTOS	Linux/Android
Power requirements (battery operation)	>1 year (0.1% duty cycle) on 700mA-hr coin cell	Line operated	Line operated
Connectivity	802.15.4/BTLE/802.11n	802.15.4/BTLE + 802.11n/ac	802.11ac + BTLE
Semicon process	55/40nm	40nm/28 nm	28nm / 16ff
Differentiators	• Security –secure boot, OTA update, virtualization • Low power • Support customer specifications for power management and power policy control • Integrated wireless connectivity • Cloud ready		

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Oberon - Scope
Use Cases

Configuration	IoT sensors	IoT M2M	IoT Sensor HUB	IoT Security
Sensor inputs	1	3+	3+	3+
Communications	802.15.4, BTLE	802.15.4, BTLE	BTLE, 15.4, WiFi	BTLE, 15.4, WiFi
Power Management	DVS, DFS, Memory retention support	DVS, DFS, Memory retention support	DVS, DFS, Memory retention support	DVS, DFS, Memory retention support
Security Omnishield™ Ready	▪ Secure boot ▪ AES/DES ▪ DPA resistance	▪ Secure boot ▪ AES/DES ▪ DPA resistance ▪ HW Virtualization	▪ Secure boot ▪ AES/DES ▪ DPA resistance ▪ HW Virtualization	▪ Secure boot ▪ AES/DES ▪ DPA resistance ▪ HW Virtualization
Memory	▪ Retention SRAM – 64KB ▪ FLASH 64K – 1MB	▪ Retention SRAM – 64KB ▪ FLASH 64K –1MB	▪ Retention SRAM – to 256KB ▪ FLASH 512KB – 2MB	▪ Retention SRAM – 64KB ▪ FLASH 512K – 2MB
CPU Range	SYS +10-20 MIPS	SYS + 10-100 MIPS	SYS + 10-100 MIPS	SYS + 10-200 MIPS
Battery Life	1 yr – 3yr	1yr+		1 yr+

Oberon - Scope

Use Cases

Configuration	IoT sensors	IoT M2M	IoT Sensor HUB	IoT Security
Sensor inputs	1	6+	3+	3+
Communications	802.15.4, BTLE	BTLE, 15.4, WiFi	BTLE, 15.4,WiFi	BTLE, 15.4, WiFi
Power Management	DVS, DFS, Memory retention support	DVS, DFS, Memory retention support	DVS, DFS, Memory retention support	DVS, DFS, Memory retention support
Security Omnishield™ Ready	▪ Secure boot ▪ AES/DES ▪ DPA resistance	▪ Secure boot ▪ AES/DES ▪ DPA resistance ▪ HW Virtualization	▪ Secure boot ▪ AES/DES ▪ DPA resistance ▪ HW Virtualization	▪ Secure boot ▪ AES/DES ▪ DPA resistance ▪ HW Virtualization
Memory	▪ Retention SRAM – 64KB ▪ FLASH 4K – 1MB	▪ Retention SRAM – 64KB ▪ FLASH 64K –1MB	▪ Retention SRAM – 256K ▪ FLASH 512K – 2MB	▪ Retention SRAM – 64KB ▪ FLASH 512K – 2MB
CPU Range	SYS + 10-20 MIPS	SYS + 10-100 MIPS	SYS + 10-100 MIPS	SYS + 10-200 MIPS
Battery Life	1yr – 3yr	1yr+	1yr	1yr – 5yr

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Oberon - IoT Smart Hub

IOT – Oberon Smart Hub

Key Features

- **Configurable Comms**
  - Dual Communication Subsystems – includes transceiver and base band
    - 802.15.4 / BTLE
      - Integrated 2.4Ghz transceiver and base band'
      - Power output – to +3dBm
    - Low power WiFi (802.11n 1x1)
      - Integrated transceiver, base band, and AFE
      - Integrated PA @+16dBm.

- **Omnishield™ Ready Secure CPU subsystem**
  - M-Class 5150 CPU with 32k L1 caches
    - Secure boot
    - Hardware virtualization
    - 150Mhz clock / 540 Coremark
    - DPA Resistance
  - On die 1.5 MB flash memory
  - 320KB System SRAM
  - Up to 128 KB retention memory
  - Encryption DMA
  - Private key Accelerator
  - OTP keys
  - Random number generator

- **Power management**
  - Integrated programmable voltage regulators
  - Supports DFS/DVS
  - Customer defined Power Management Policy
  - Operating/Sleep (with data retention) / hibernate modes

- **Peripherals**
  - 2x I2C
  - 3x UART
  - 3xI2S (2 input, 1 output)
  - 3x SPI
  - SDIO - slave
  - 16/32 GPIO

- **Analog support**
  - 8ch 12 bit A/D @1MHz

- **Technology – TSMC 40uLP**

- **Operating voltage:**
  - 3.3v (battery or line powered)

- **Die Size: 24.5 mm^2**

- **Package –** 36 pin to 100 pin QFN

Oberon - IoT Smart Device

IOT – Oberon Smart Device

Key Features

IMGworks
by Imagination

- **Configurable Comms**
  - BLE/802.15.4 Communication Subsystems – includes transceiver and base band
    - Integrated 2.4Ghz transceiver and base band'
    - Power output: to +3dBm

- **Omnishield™ Ready Secure CPU subsystem**
  - M-Class 5150 CPU with 32k L1 caches
    - Secure boot
    - Hardware virtualization
    - 150Mhz clock / 540 Coremark
    - DPA Resistance
  - On die 1MB flash memory
  - Up to 64KB retention memory
  - 128KB System SRAM
  - Encryption DMA
  - Private key Accelerator
  - OTP keys
  - Random number generator

- **Power management**
  - Integrated programmable voltage regulators
  - Supports DFS/DVS
  - Customer defined Power Management Policy
  - Operating/Sleep (with data retention) / hibernate modes

- **Peripherals**
  - 2x I2C
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  - 3xI2S (2 input, 1 output)
  - 3x SPI
  - SDIO - slave
  - 16/32 GPIO

- **Analog support**
  - 8ch 12 bit A/D @1MHz

- **Technology – TSMC 40uLP**

- **Operating voltage:**
  - 3.3v (battery or line powered)

- **Die Size: 13.8 mm^2**

- **Package –** 36 pin to 100 pin QFN

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Oberon Differentiation for IoT

- **Power management**

- **Security - Omnishield™ ready**

- **Integrated Wireless Connectivity**

- **Seamless interface from device to cloud**
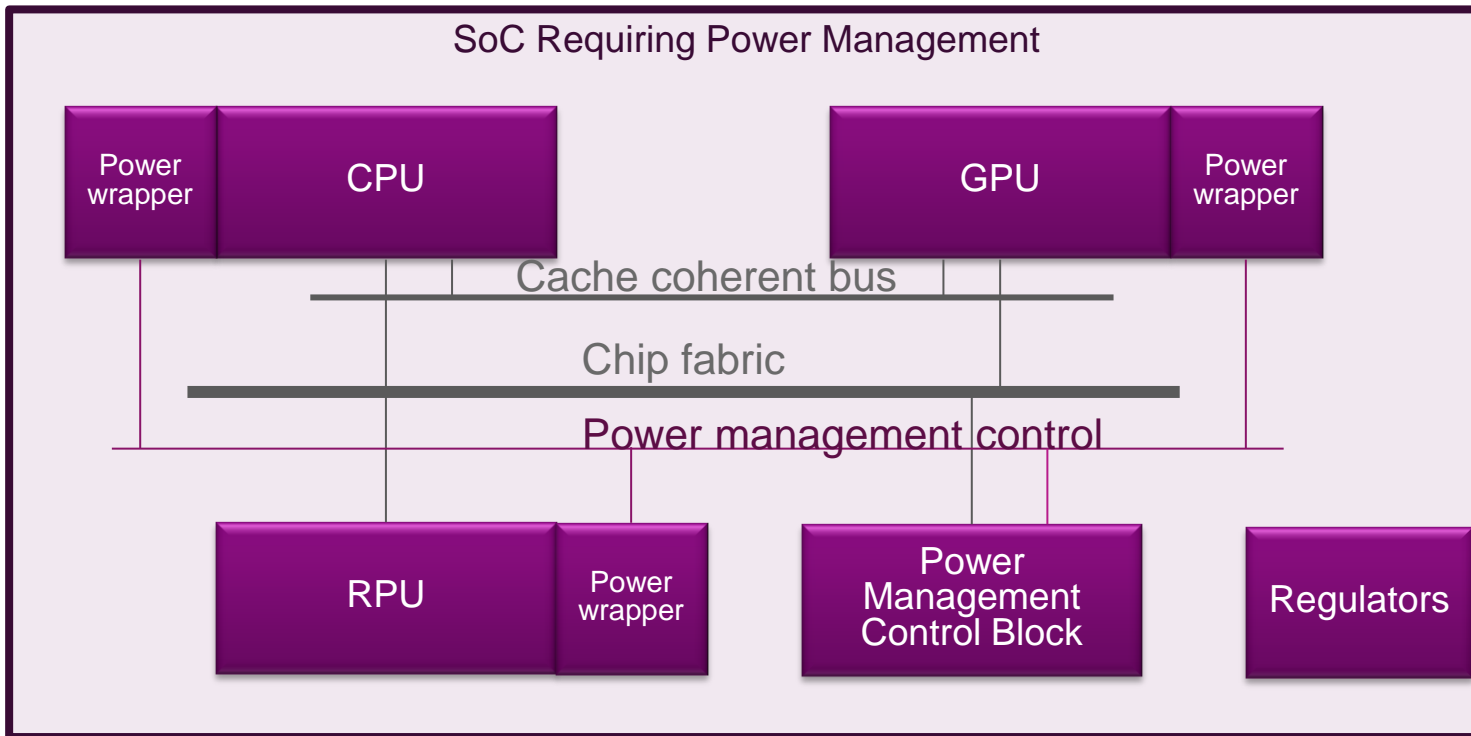
IoT Power Management

October 2015

Features of IoT Power Management Control Block

- **Provide the hardware support for voltage scaling and frequency scaling**

- **Provide the hardware support for enabling the power modes for each functional block that will have power down modes.**

- **Contain an always on 32Khz Time of Day clock.**

- **Provide counter/timers**

- **Provide external inputs that will enable the chip (or regions in the chip to assume specific power modes.**

- **Provide control for power mode policy**

Integrated Switching and Linear Regulators

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Power Management Architecture

SoC Requiring Power Management

Power wrapper | CPU

GPU | Power wrapper

Cache coherent bus

Chip fabric

Power management control

RPU | Power wrapper

Power Management Control Block

Regulators

- ✓ Support dynamic voltage scaling
- ✓ Support dynamic frequency scaling
- ✓ Power management wrapper defined for IP.

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CPU and RPU Power Optimization

- **Uses Power optimized std cell libraries and memories**
  - Narrow libraries (7 track, 9 track)
  - Low power optimized library
  - Power management kit to support voltage islands, power gating, etc.
  - Low power memories with leakage control
  - Low data retention voltage (0.66v).

- **Defined Power modes**

Power State	Power applied	Clocks applied
On	V_{DD} Nominal	F_{CLK} = Full speed
Idle	V_{DD} Reduced	F_{CLK} = Reduced
Sleep	V_{DD} MIN only for memory and F/F state retention	F_{CLK} = gated off
Off	V_{DD} Off	F_{CLK} = gated off

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Targeted Power 40 nm – embedded MIPS M5150

MIPS embedded CPU

IP block	Power Mode	Supply voltage	Power consumption (est).	Other
M5150 CPU	Active	0.81v	M5150: 32K I$ and D$ - 3.2 mW Core: 1.8mW (9uW/Mhz)	200Mhz
M5150 CPU	Active	0.75v	M5150: 32K I$ and D$ - 1.6 mW Core: 0.8mW (8uW/Mhz)	100Mhz
M5150 CPU	Data retention mode	0.66v	<500 nW	

Targeted Power 40nm – Wireless Comms

Standard[1]	Transmit	Receive	Connected Standby	Deep Sleep
802.11 b/g/n 1x1 11n Output Power (10 dBm / 16 dBm)	240 mW 684 mW	72 mW	80uW (DTIM-3) 30uW (sleep mode)	1.2 uW
BLE 0 dBm output	9 mW	8 mW	N/A	< 1.0 uW
802.15.4 3 dBm output	< 40 mw	< 12 mW	N/A	< 1.0 uW

[1]All power numbers include transceiver, baseband, and AFE

Oberon Security Features

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Security– Omnishield™ Ready

Provides TPM and common security functions

- Secure Boot

- Secure Code updates

- Key Protection

- DPA resistant

- Access Control of Secure resources

- Enables system level secure mode of operation

- Secure DMA Channel for critical functions

- Run time Integrity Checks

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Platform Security Subsystem

Key Components
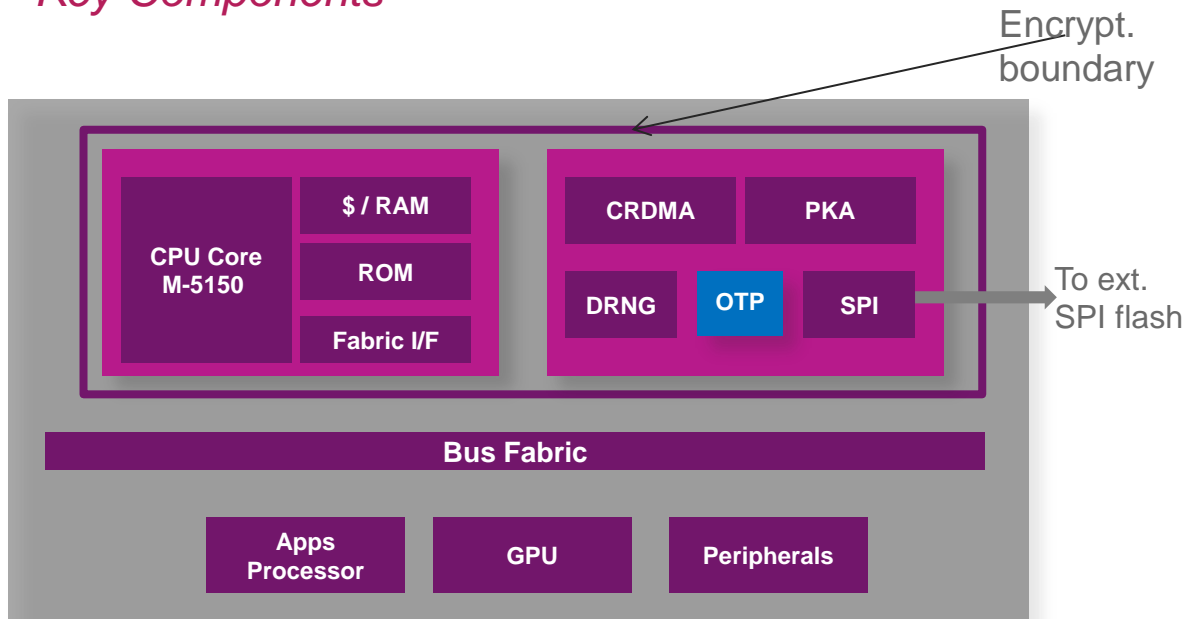
- **Integrates security for secure boot, secure SW update, CRDMA, OTP keys, PKA**

- **Provides Root of Trust upon power up.**

- **Security Subsystem is inside crypto boundary**
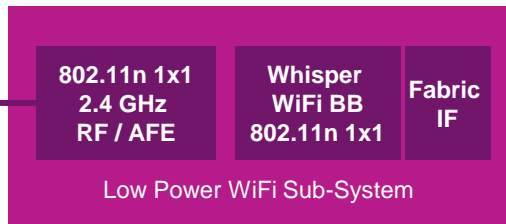
- **Security IP Subsystem is a licensable product**

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# IoT Integrated Wireless Connectivity

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Wireless Connectivity Subsystems

| 802.11n 1x1 2.4 GHz RF / AFE | Whisper WiFi BB 802.11n 1x1 | Fabric IF |

Low Power WiFi Sub-System

| BLE / 802.15.4 2.4 GHz RF / AFE | Whisper WiFi BB BLE / 802.15.4 | Fabric IF |

Low Power BLE / 802.15.4 Sub-System

- **Low Power WIFI subsystem**
  - Single band 2.4Ghz radio + Integrated PA to +16dBm
  - Includes Whisper BB + WiFi AFE + transceiver
  - Compliant to 802.11n
  - Supports soft AP, WiFi Direct, and client modes
  - Subsystem IP certified on Oberon
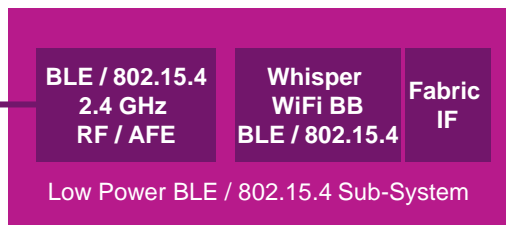
- **BTLE / 802.15.4 subsystem**
  - Single band 2.4Ghz plus integrated PA to +3dBm
  - Includes Whisper BB + AFE + transceiver
  - Subsystem IP qualification on Oberon
  - optimized for low power 8 mW TX and RX power

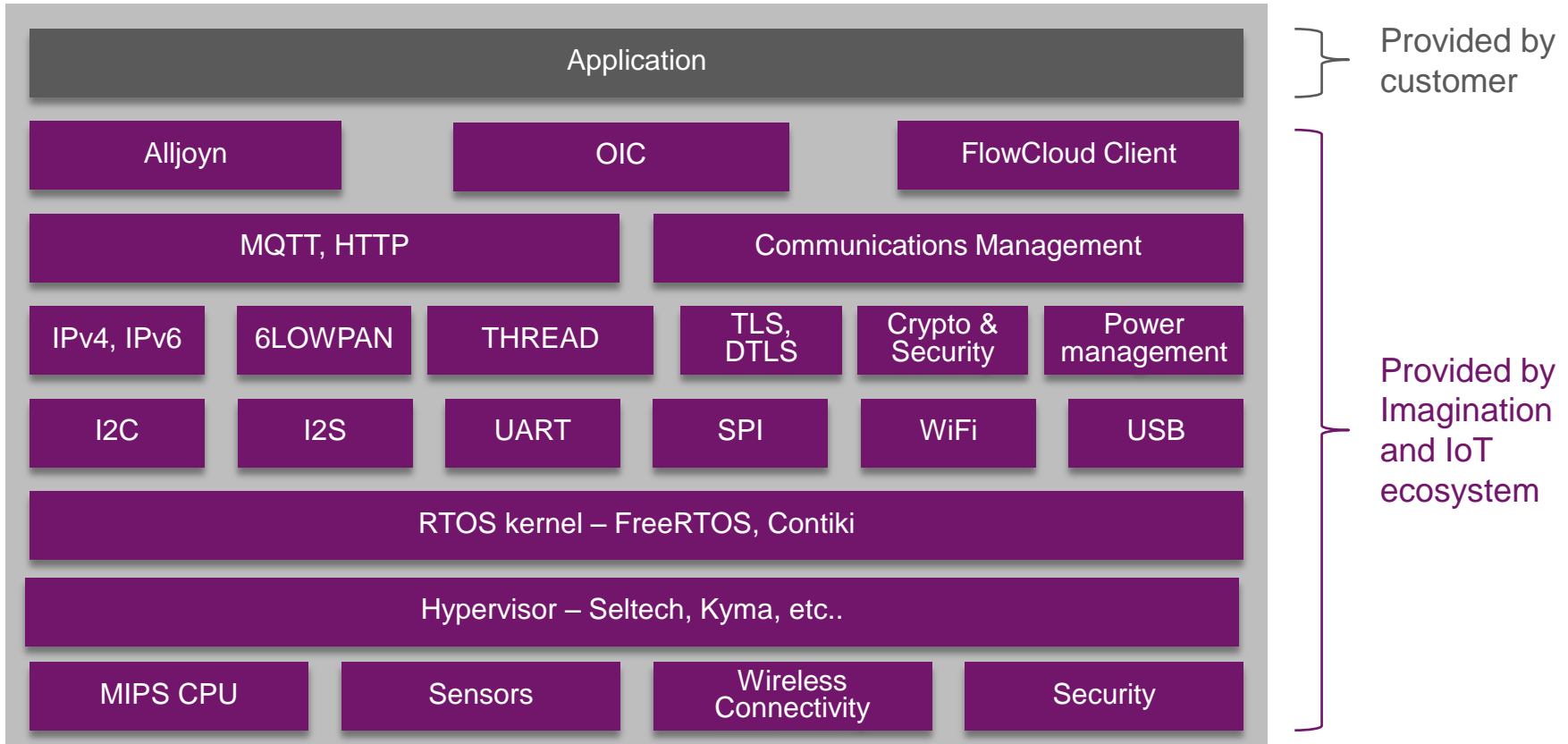**IoT Seamless Interface from Device to Cloud**

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IoT Software architecture

Application

Provided by customer

Alljoyn	OIC	FlowCloud Client

MQTT, HTTP	Communications Management

IPv4, IPv6	6LOWPAN	THREAD	TLS, DTLS	Crypto & Security	Power management

I2C	I2S	UART	SPI	WiFi	USB

RTOS kernel – FreeRTOS, Contiki

Hypervisor – Seltech, Kyma, etc..

MIPS CPU	Sensors	Wireless Connectivity	Security

Provided by Imagination and IoT ecosystem

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Oberon Schedule

- **Specification**
  - High Level Specification   - June 30, 2015
  - Detailed Specification   - Aug. 2015
- **Oberon Tapeout**   - Q3/2016
- Silicon bring up platform   - Q4/2016
- Customer development platform   - Q4/2016
- Software
  - Contiki   - Q2/2016
  - FreeRTOS   - Q3/2016
  - Customer specified   - TBD

Platform Business Model

- **Phase 1: Chip development**
  - NRE fee covers the following
    - Finalize chip level spec requirements
    - IP license
    - Development of the chip RTL and gdsii
    - Tape out MPW for samples; Customer typically gets up to 100 samples
      - Customer to confirm samples meet requirement.

Typical Business Model (2)

- **Phase 2: Production**

  - Customer has two options

    - **Option 1:** Customer take to production

      - Chip manufacturing license fee, royalty per unit.

      - Customer proceeds by himself to take to production

    - **Option 2:** Imagination or its 3rd party production partner takes to production

      - Customer pays manufacturing tooling costs including:

        - Package development

        - Masks

        - Reliability qualification