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EnerHarv 2022 Workshop:

Space Constrained Devices with Ultra-low Power Consumption Budget Powered by the SIMO Architecture

Presented By –

Gaurav Mital, Analog Devices

Product Definition/System Architecture, Consumer Power Group

Wednesday, April 6, 2022

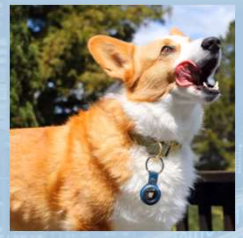
OVERVIEW

- **Is Harvesting Energy the right option for your system?**
- **Energy Harvesting System Considerations**
- **Maximizing Harvested Energy**

Harvesting Applications

Accessory Trackers

Asset Trackers



Wind Turbine
Smart Screws

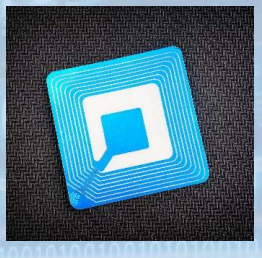
Industrial IoT

Fitness Wearables

Wireless Sensor Nodes

Smart Meters

Consumer
Smart Devices



Smart Sensors

So I've reduced my IQ. Should I harvest or use a primary cell?

For a 100mAh Battery:

Total Power Budget	Run-Time	Comment
1uA	11.4 years	Harvesting is not needed
10uA	1.14 years	Harvesting starts getting interesting
100uA	1.37 months	Harvesting is very interesting
1000uA	4.1 days	Harvesting is probably not enough

- Harvesting is attractive for 10uA to 200uA power budgets.
  - > **Lower limit**: Low interest due to excellence of primary cell.
  - > **Upper Limit**: Low interest due to size/cost of solar
- Harvesting vs. Primary Cell
  - > Harvesting reduces battery size & cost vs. extra size/cost of solar
  - > Harvesting makes device potentially perpetual

PV cell

Power Levels Available for Energy Harvesting



Far — Wireless (NFC) — Near

Human — Thermal Gradients — Machine

Human — Kinetic — Machine

Indoor — Solar — Outdoor

1 µW — 3 — 10 — 30 — 100 — 300 — 1,000 — 3,000 — 10,000 — 30,000uW

Low-Power Device Challenges

Consumer

Keeping devices lightweight and ensuring long run-time

Industrial

Dependence on manual servicing and connecting infrastructure

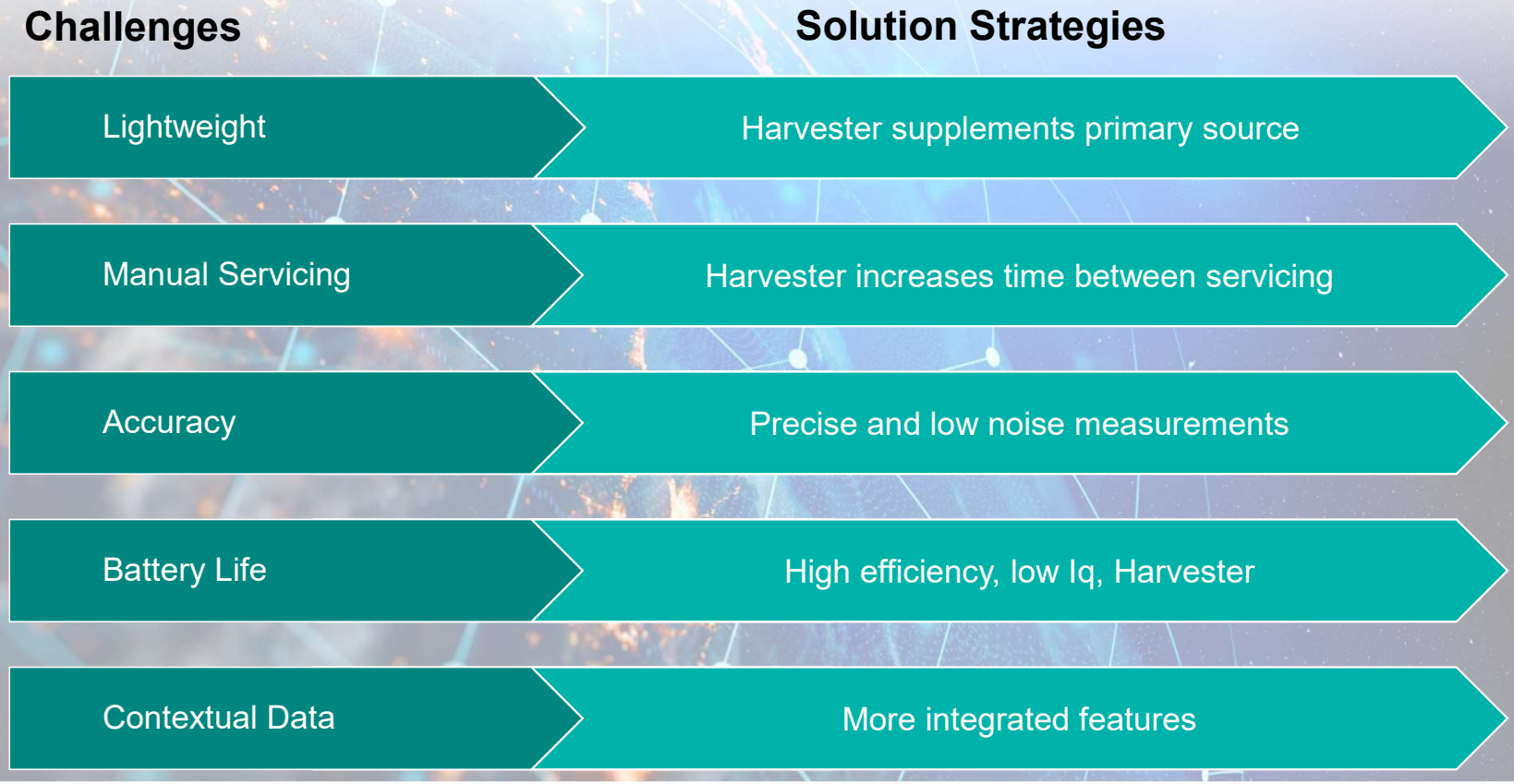
Environmental

Numerous hard to access nodes

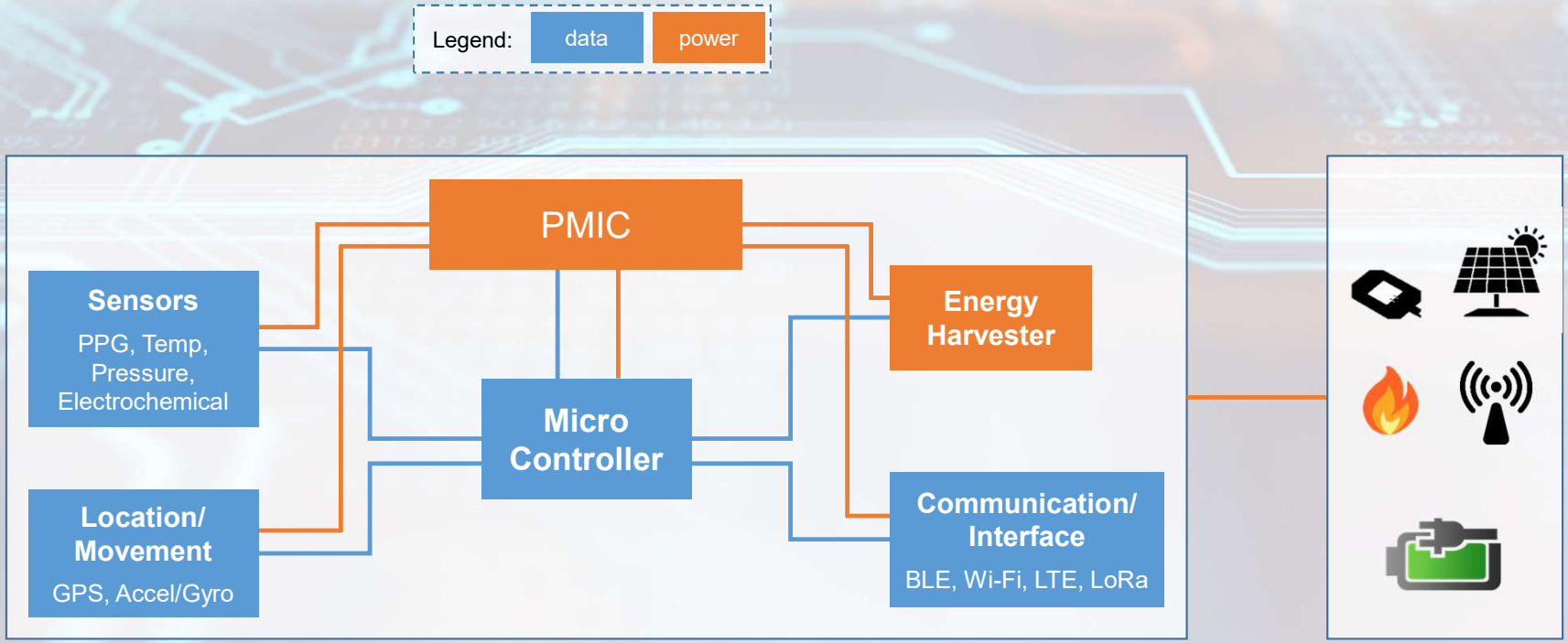
Non-renewable power source reliance

Needing to rely on batteries or grid for 100% of system power

Harvesting as Solution to Low-Power Device Challenges

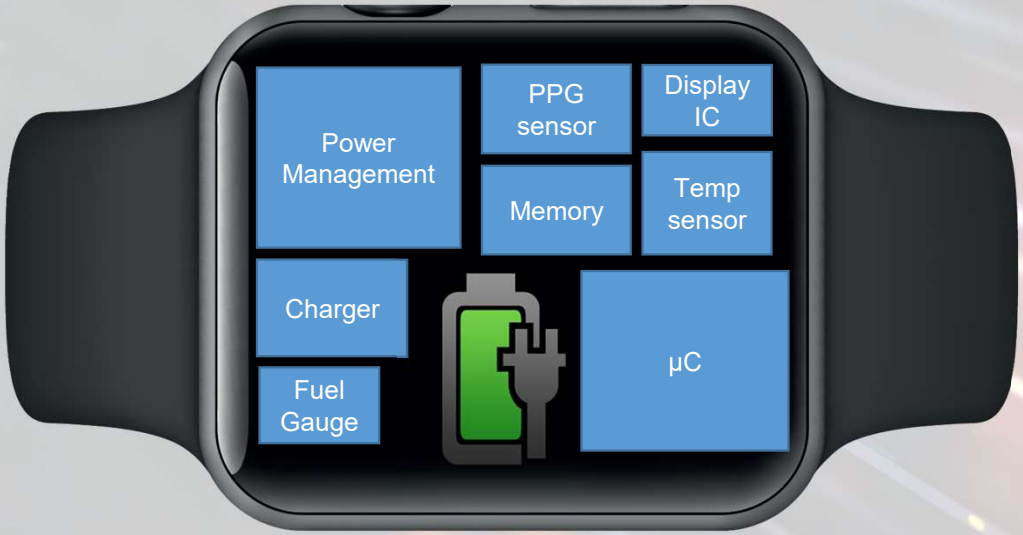


Sensor System with Energy Harvesting

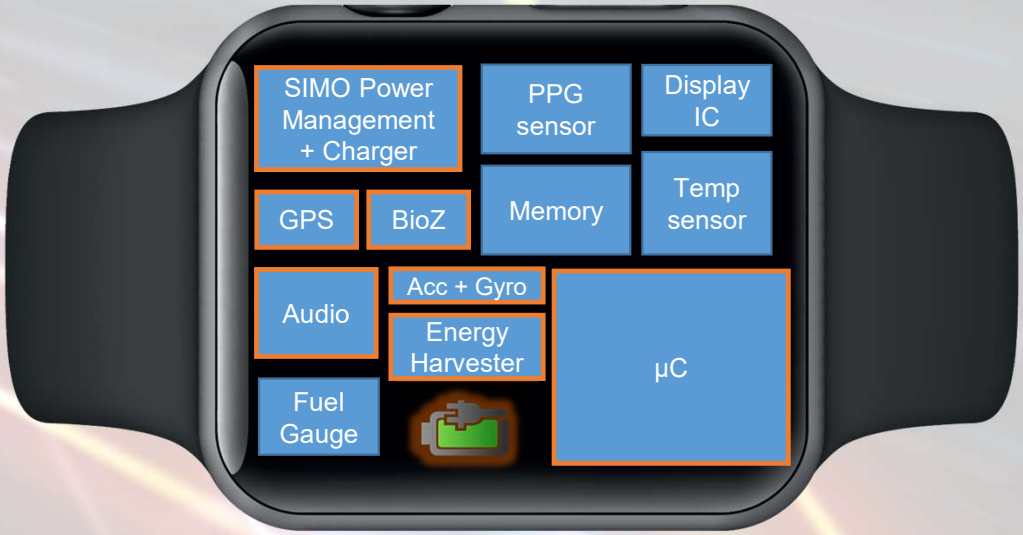


Need for More Integrated Features

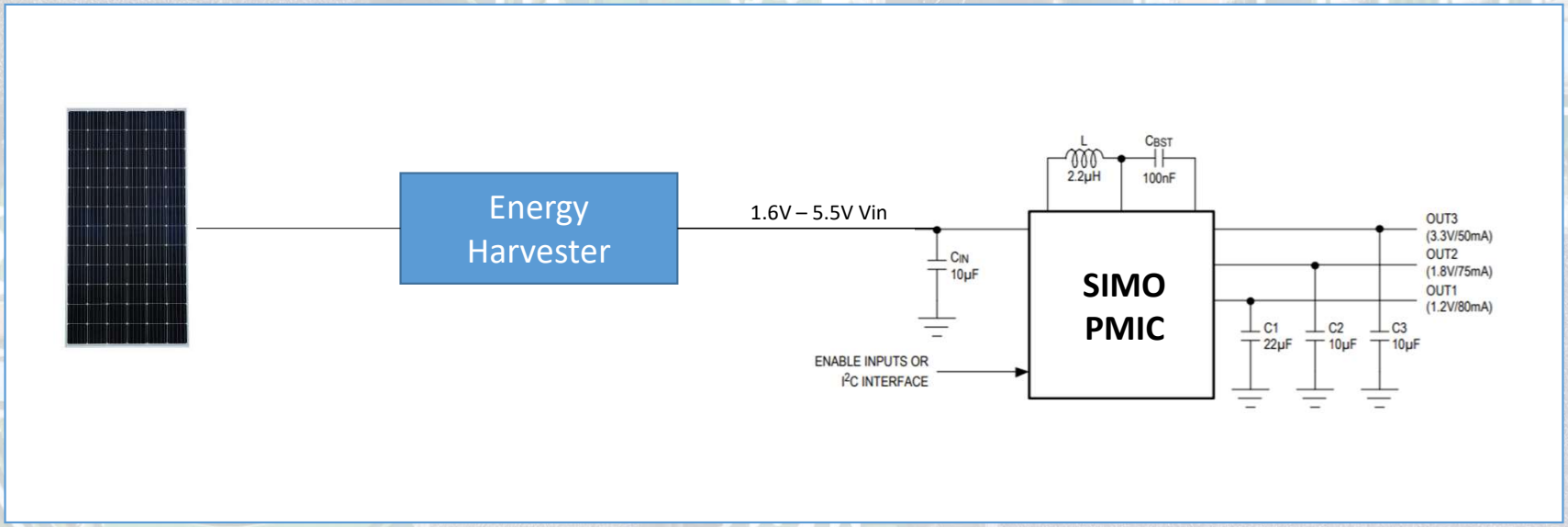
Traditional Solution



Feature-Rich, Next-Gen Solution



Solar Harvester + SIMO PMIC



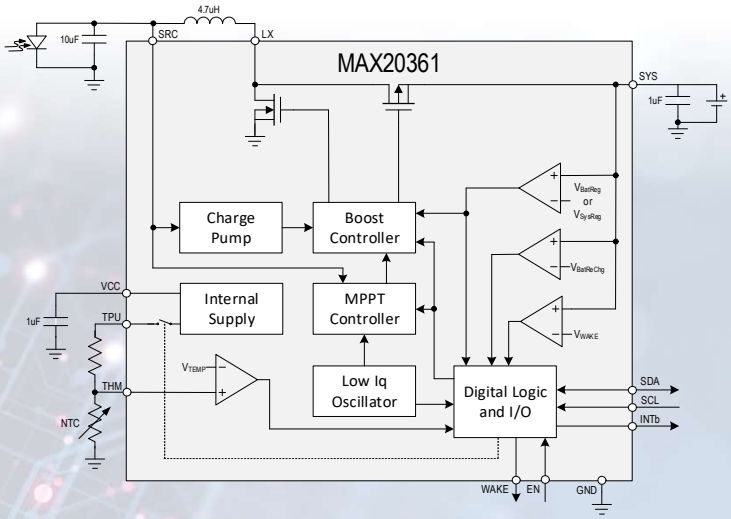
Solar Harvester
MAX20361

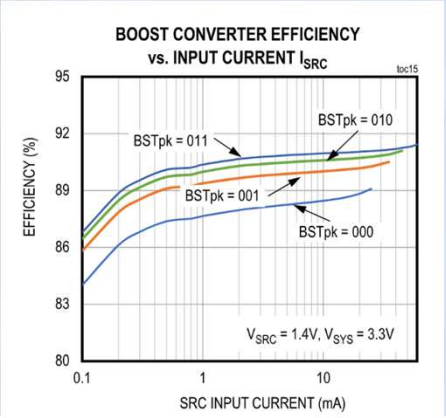
Benefits

- Increase device operation time by supplementing battery energy with solar or sole source solar
- Efficient harvesting 15µW to 300mW IP power
- Small solution size

Features

- Low V_{IN}, low I_Q boost
  - > 225mV to 2.5V input range (up to 3 cells)
- High efficiency charging
- Adaptive Maximum Power Point Tracking (MPPT)
- Integrated harvesting gauge
- Small solution size
  - > 1.23 x 1.63mm WLP package





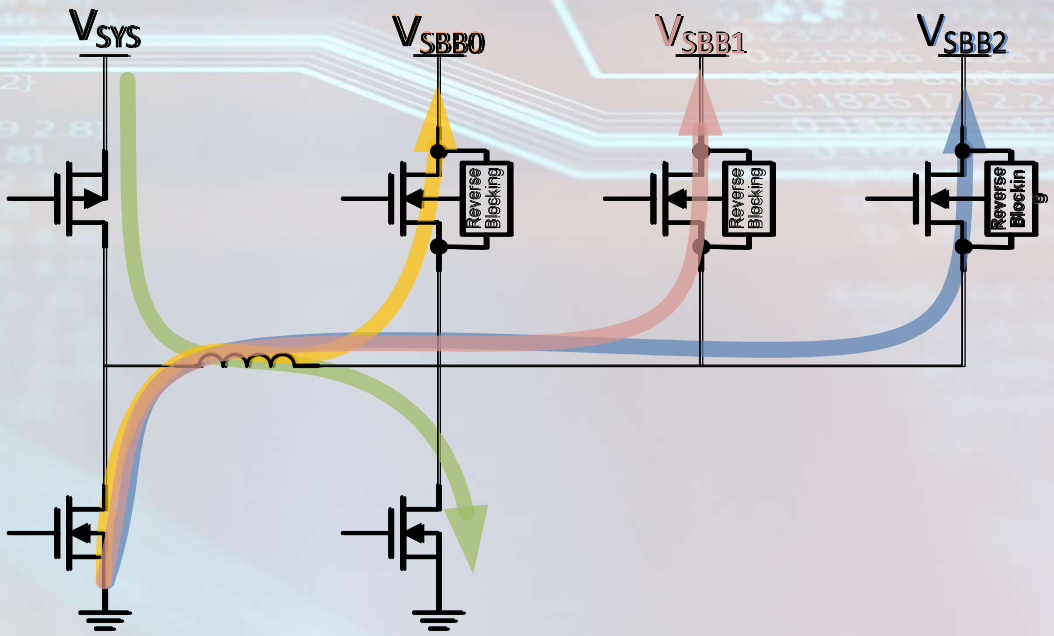
Power savings from Power Management

- **Multiple high-efficiency voltage rails**
- **Low quiescent current**
- **Auto wakeup**
- **Dynamic voltage scaling (DVS)**
- **Versatile power source configurations**
- **Solution size savings**

Single Inductor Multiple Output (SIMO) Technology

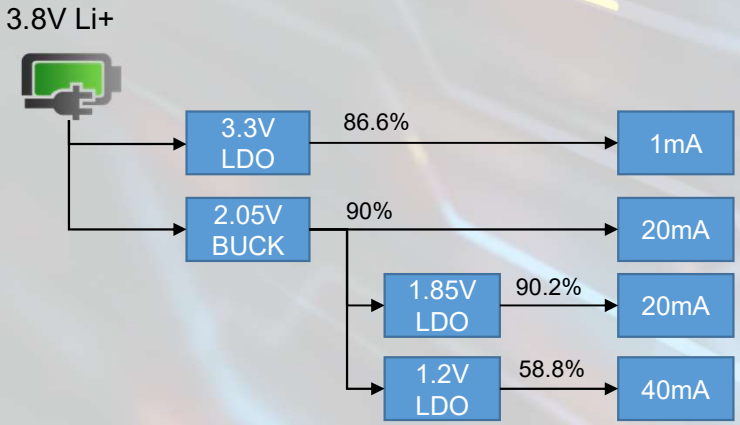
SIMO Architecture

- 50% Smaller Solution
- 20% Longer Battery Life
- High Signal Integrity
- Wide Input Range

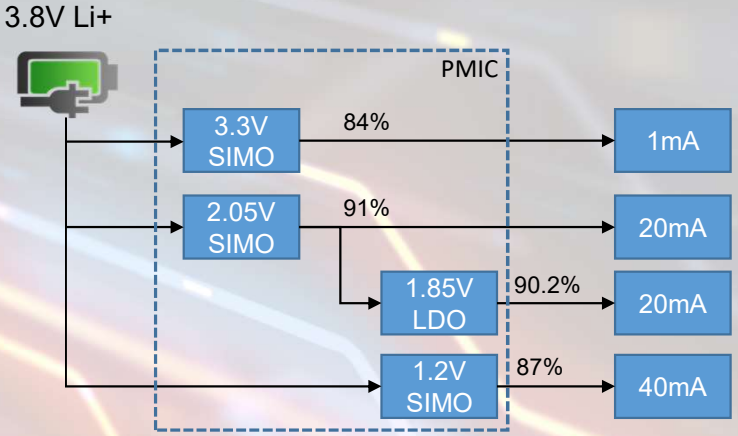


Increasing Battery life by 20%

Traditional Solution
System Eff = 69.5%



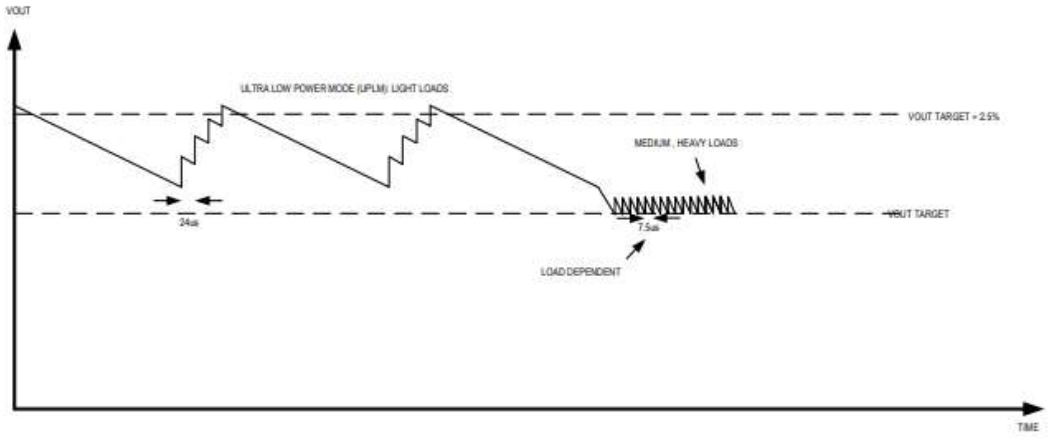
SIMO Power Management
System Eff = 86.1%



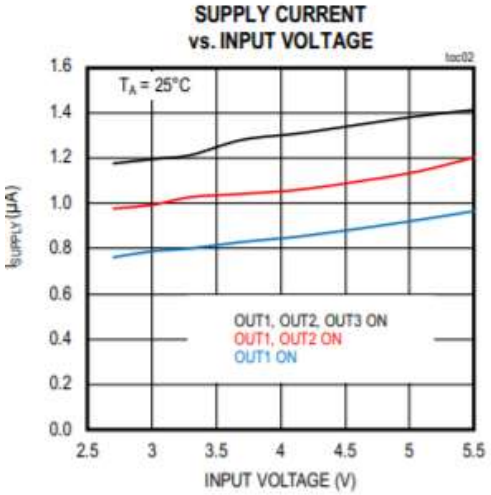
Key Parameters	Traditional Power Management	SIMO Power Management
BATT Current	49mA	39.5mA
System Efficiency	69.5%	86.1%

Nano Power Quiescent Current

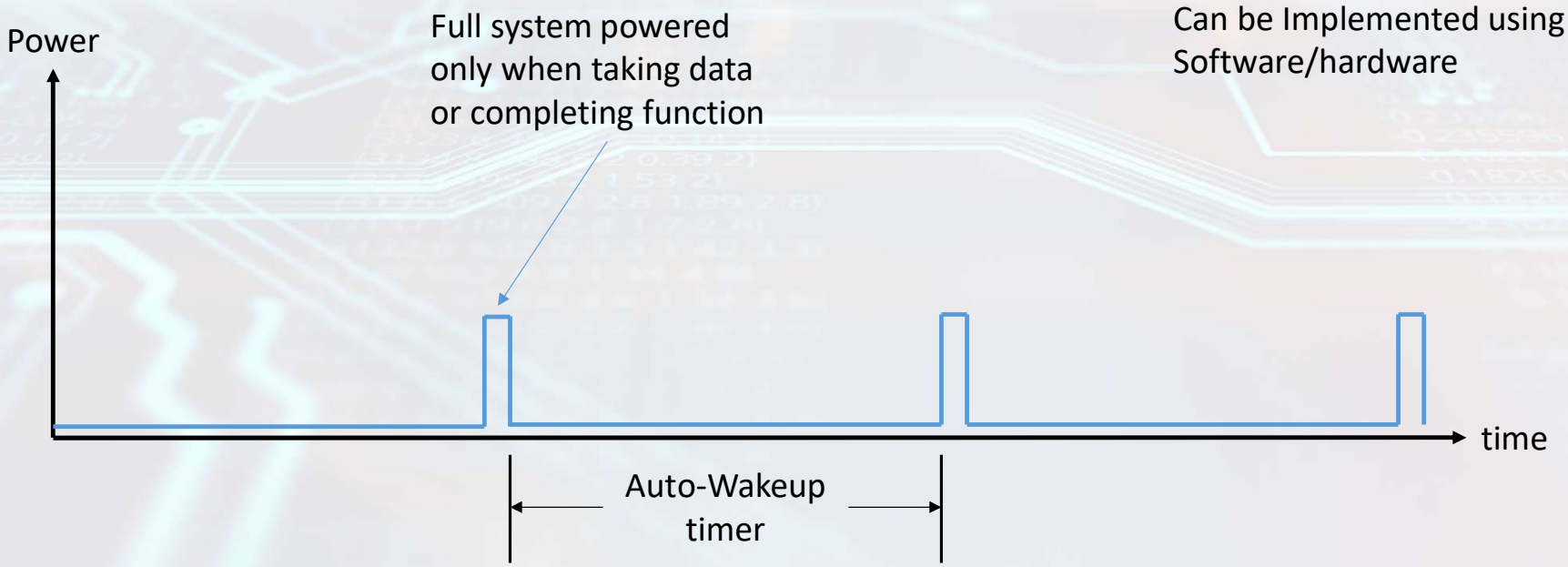
Ultra Low Power Mode Operation



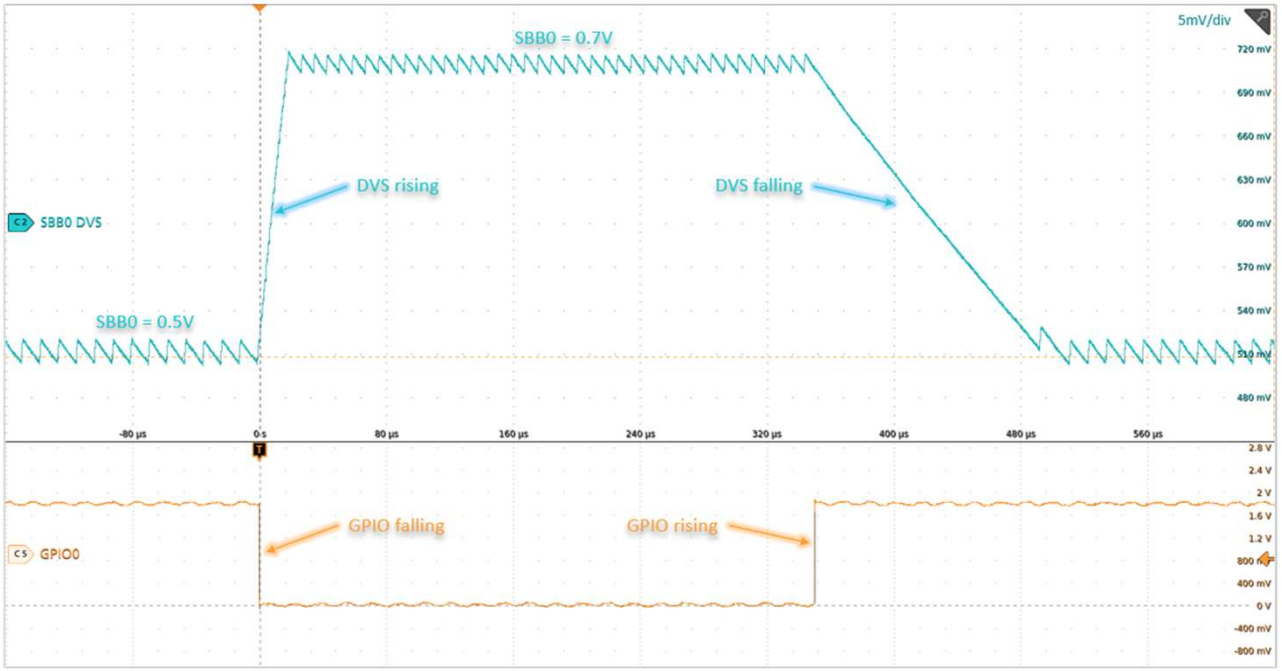
Supply Current in Nano Amps



Use Power only when needed with Auto Wakeup



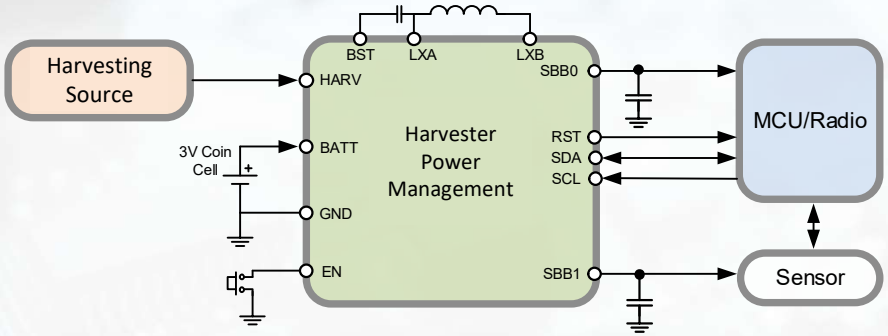
Dynamic Voltage Scaling



$$P_{loss} \propto V^2$$

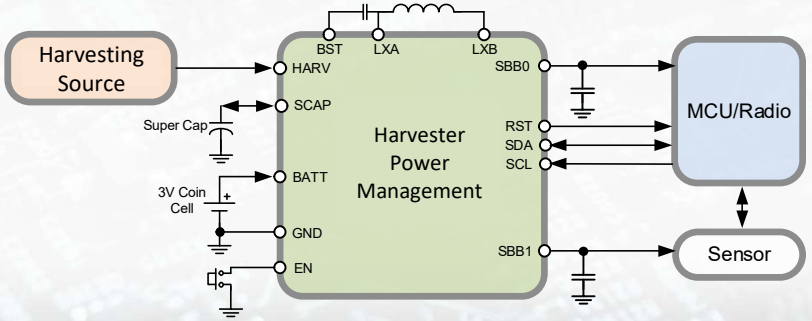
- By reducing operating voltage when functional demands are lower, power loss is reduced
- DVS is controlled via GPIO/I²C

Energy Harvesting with Versatile Battery Configurations

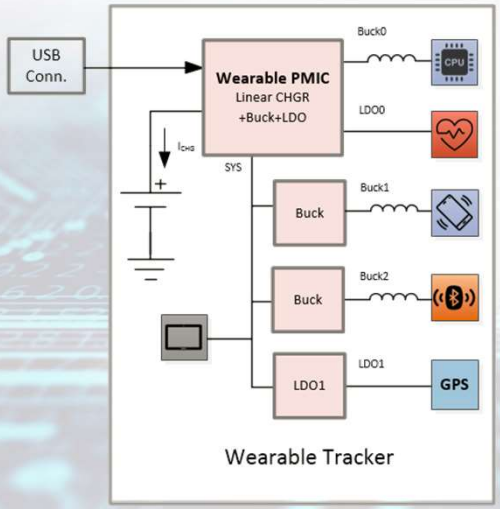


Harvester + Primary cell

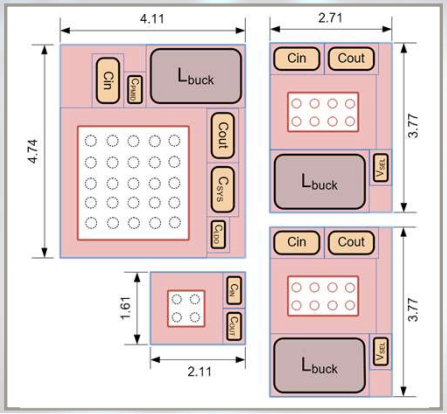
Harvester + Supercap + Primary cell



Space Saving



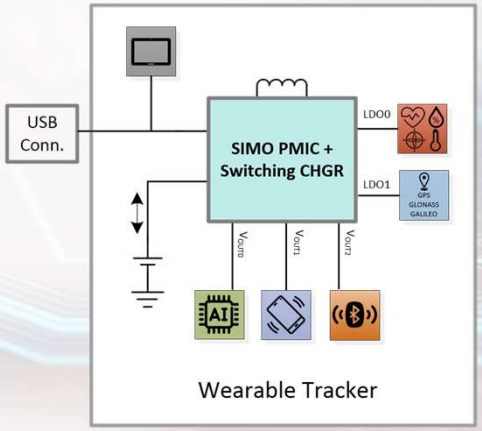
Traditional IoT Architecture



Solution Size: 43.31mm²

Component Count: 20

Next-Gen IoT Architecture

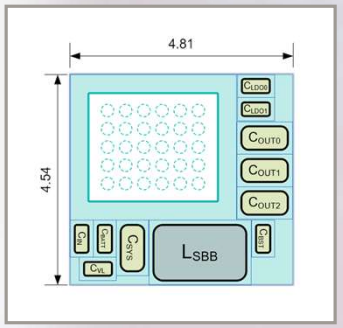


50% Smaller

Solution Size: 21.83mm²

Component Count: 12

40% Lower BOM Count



Closing comments

- **Lower down-stream power consumption**
  - **PMIC, Microcontroller, Sensors, RF**
- **Widen Input voltage range**
- **One stop power solution for harvesting + power solution**
- **Higher harvester efficiency**

Q & A

Thank You