Renesas Synergy Concept

Much more than a microcontroller family

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Much more than a microcontroller family

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Developers know that time to market is a huge factor in a company's success.
Missed deadlines mean lost opportunities that can often never be replaced.
The Renesas Synergy Platform allows developers to save precious design time and get their products to market faster.
This session will give you a brief overview of this innovative concept; a game changer in embedded development of both software and hardware.

Presented by:

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Avnet Silica

Avnet Silica is the European semiconductor specialist division of Avnet, one of the leading global technology distributors, and acts as the smart connection between customers and suppliers. The distributor simplifies complexity by providing creative solutions, technology and logistics support. Avnet Silica is a partner of leading semiconductor manufacturers and innovative solution providers over many years. With a team of more than 200 application engineers and technical specialists, Avnet Silica supports projects all the way from the idea to the concept to production.

QUICK FACTS

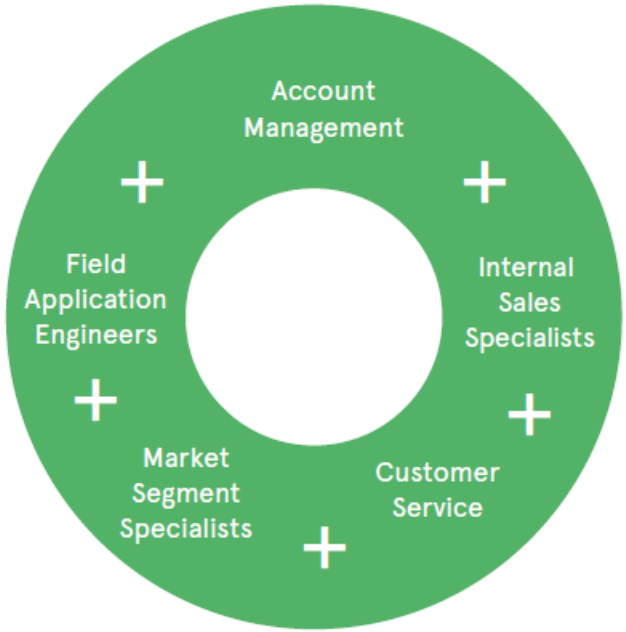
- Focus on semiconductor market
- 940+ employees across Europe
- 46 offices in 22 countries across EMEA
- 70 selected franchises on highly specialised linecard
- avnet-silica.com

avnet-silica.com

Avnet Silica is the smart connection between our Customers and our Suppliers. We simplify complexity by providing creative solutions, technologies and logistics via our passionate, energized and empowered team.

Avnet Silica provides the best technologies, services and ideas to high-tech companies across Europe. We listen to our customers' challenges and turn them into competitive opportunities. Our people are engaged customer advocates. They act fast and ensure a seamless execution.

OUR SUPPORT STRUCTURE



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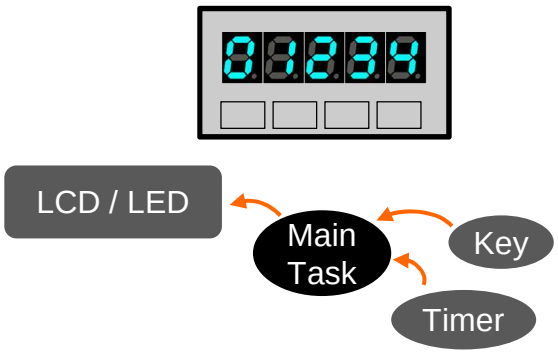
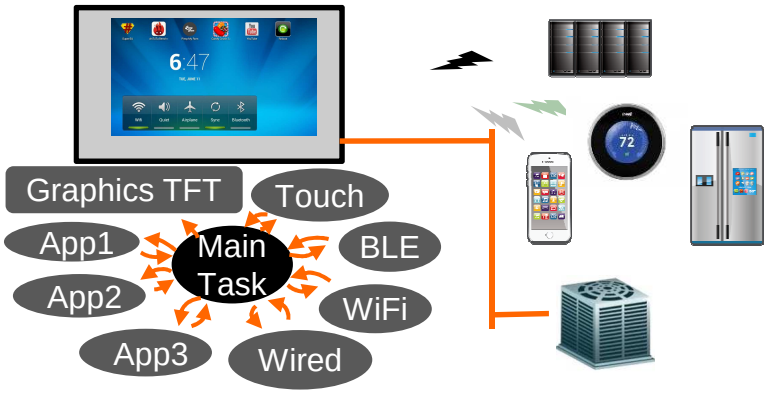
Embedded Systems Have Changed

Legacy Embedded System



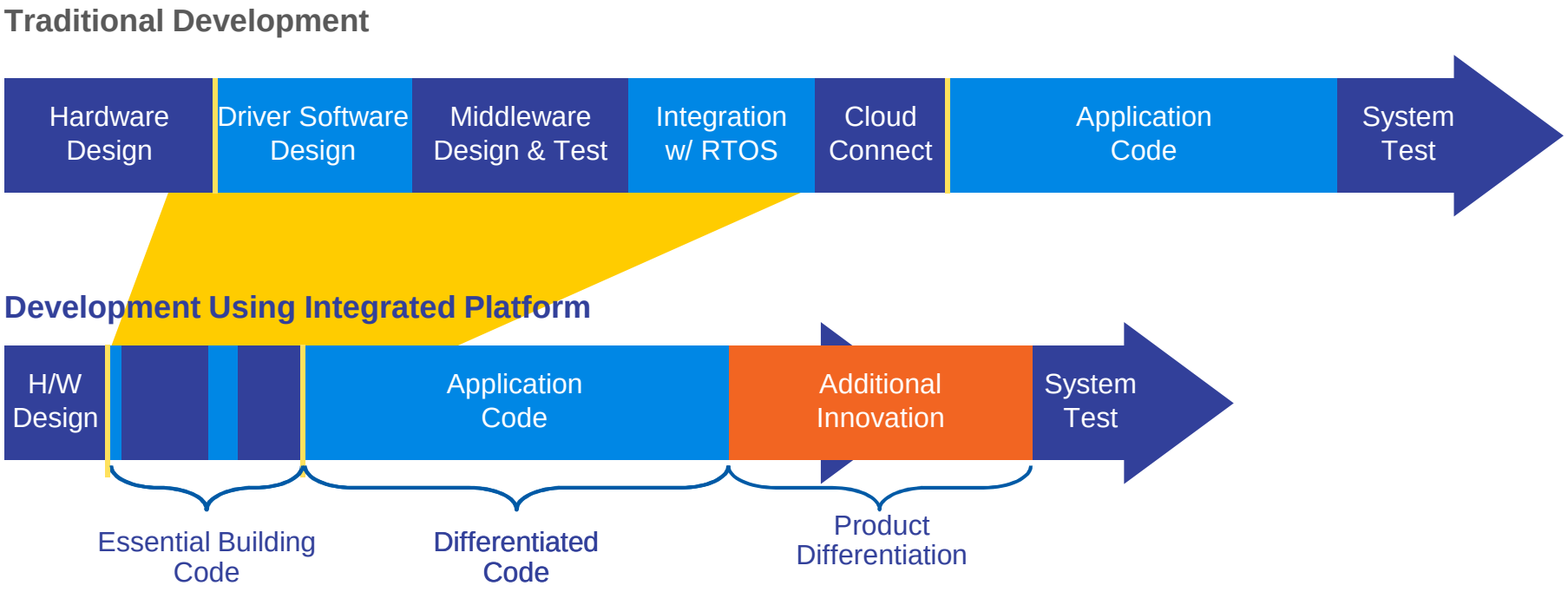
- Single function
- Closed within the device
- A few interrupt sources

Connected Embedded System

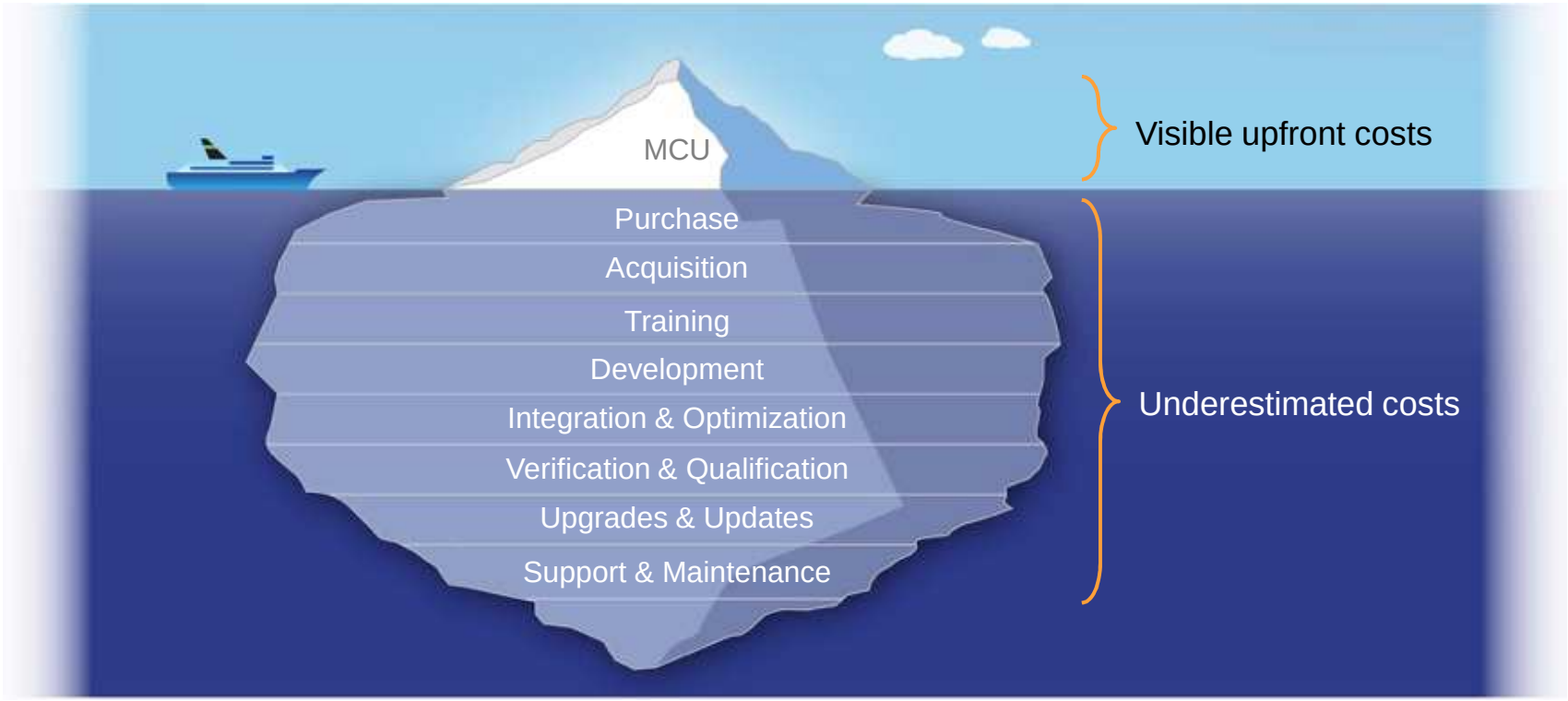


- Multi-function
- Connected with devices via network
- Many interrupt sources

Developers Want to Reduce Development Time



Developers Want to Minimize Total Costs



How Does Synergy Platform Address These Needs?

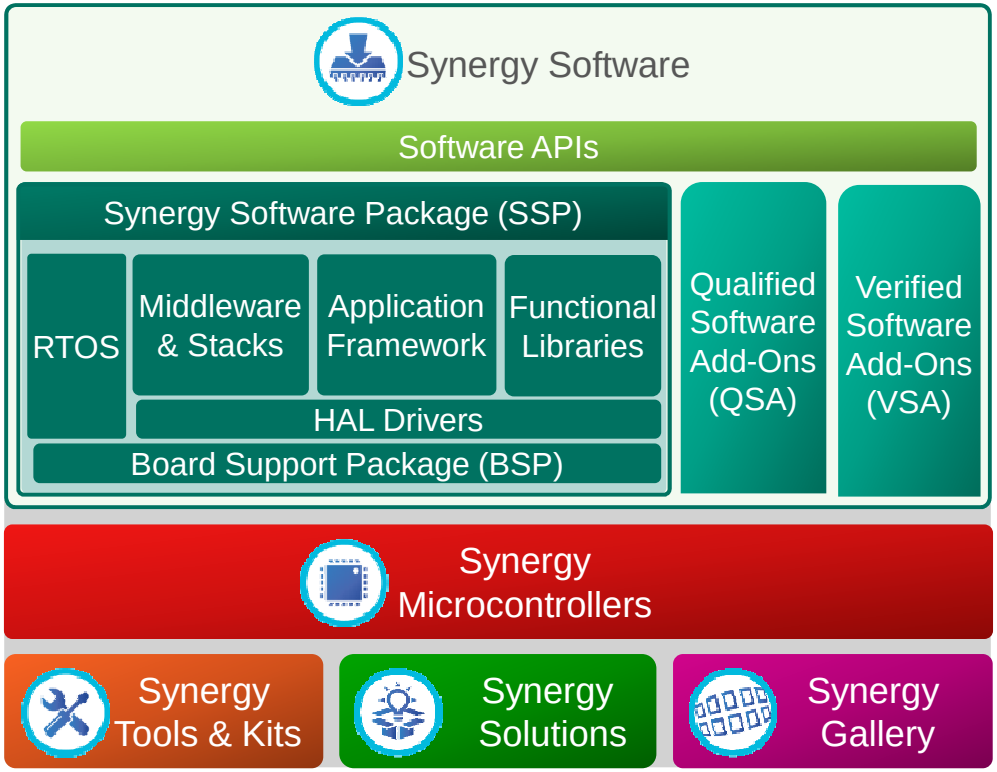
An Ideal Platform for Embedded Developers

RENESAS synergy™

A complete and qualified platform that **accelerates** embedded development, inspiring **innovation** and enabling **differentiation.**

Our Three Values

- **Faster Time to Market**
- **Reduce Total Cost of Ownership**
- **Lower Barriers to Entry**



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What it is: Synergy Platform Elements

Software

- Qualified Synergy Software Package (SSP) for guaranteed operation
- Complete package fully integrated and maintained
- Applications can be written at the Software API level

Microcontrollers

- Wide MCU spectrum based on 32bit ARM® Cortex®-M CPU cores
- Completely scalable and pin compatible
- On-chip Flash memory up to 4 MB
- Security & encryption acceleration
- Ultra low power

Tools & Kits

- Integrated Solution Development Environment (ISDE) with context-aware documentation
- Starter Kits (SK) and Development Kits (DK) for immediate access to entire software package

Solutions

- Product Example (PE) kits: Complete design journeys representative of end-product designs
- Application Example (AE) kits: Technology building-block examples to build upon

Gallery

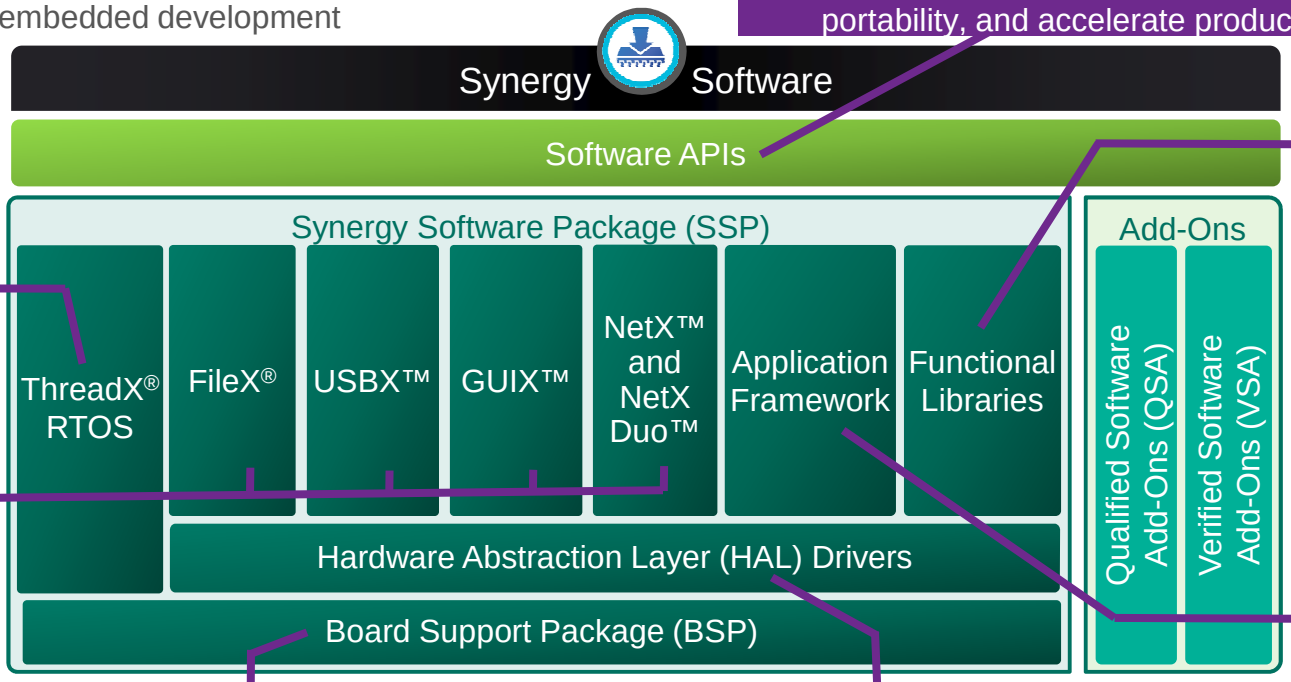
- Web access to Synergy specific software, tools, licensing plus 3rd pty software & services
- Future growth to complete secure cloud access infrastructure for end-products to use

Renesas Synergy™ Software

Redefining embedded development

Software APIs
Standardized 'C' language APIs for X-Ware™, Application Framework, Middleware, Libraries, DSP, HAL, BSP, and MCU registers. Abstract the dependencies, ensure portability, and accelerate product development.

ThreadX® RTOS
Multitasking real time kernel with preemptive scheduling and small memory footprint. Stable heartbeat of the system.



Libraries
Specialized software for DSP, touch, security, safety, and more.

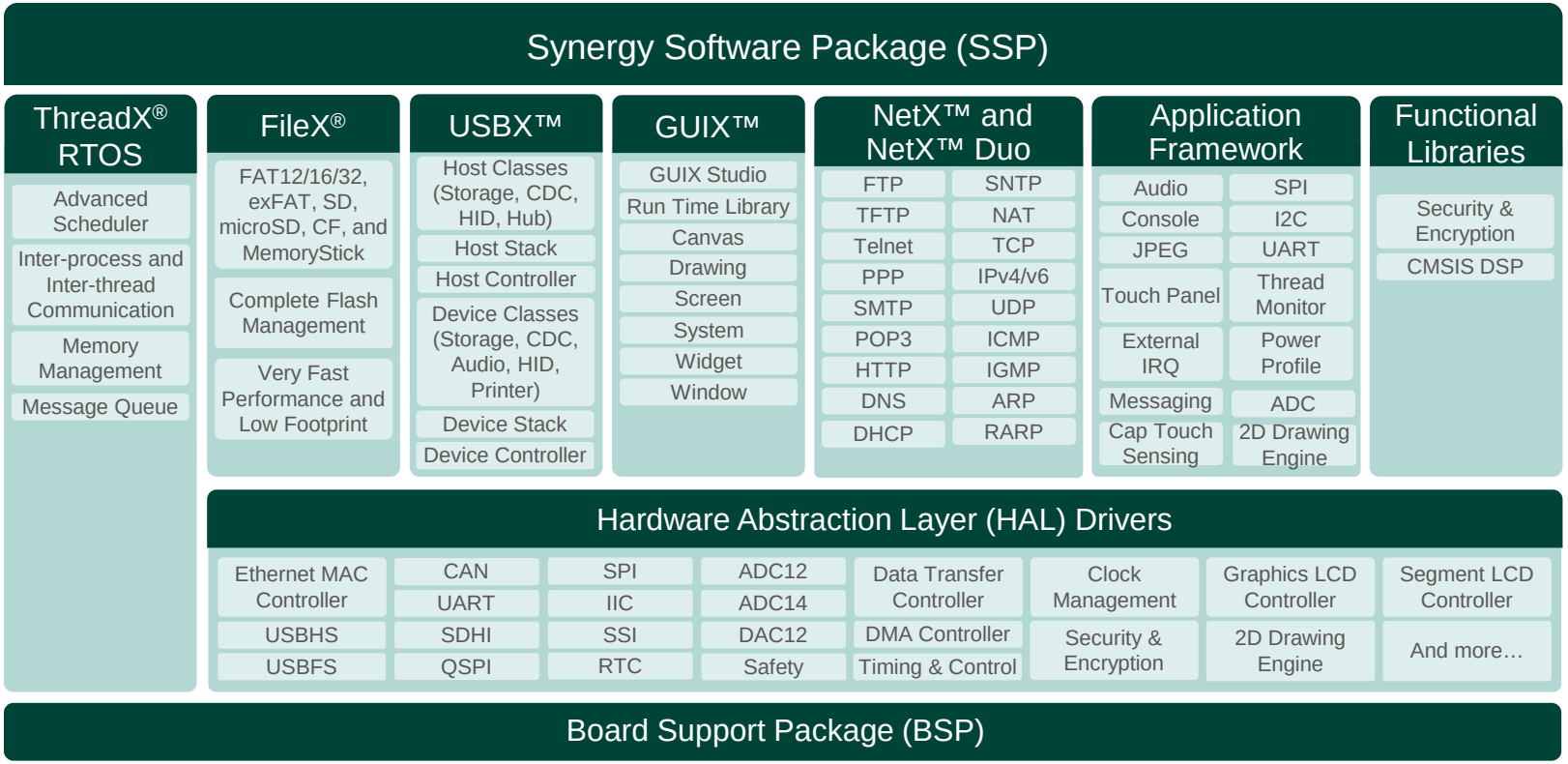
Stacks & Middleware
X-Ware™ for TCP/IP, USB, color graphics, and file system. Completely optimized and integrated.

Application Framework
System level services linking RTOS to HAL for inter-process messaging, security services, audio playback, serial comm, power mgmt, JPEG conversion, touch, and more. Saves time.

Board Support Package
Customized for every Synergy hardware kit and MCU. Easily tailored for end-product.

Hardware Abstraction Layer
Efficient drivers for all peripherals and system services. Eliminates deep study.

Renesas Synergy™ Software Package – Block Diagram

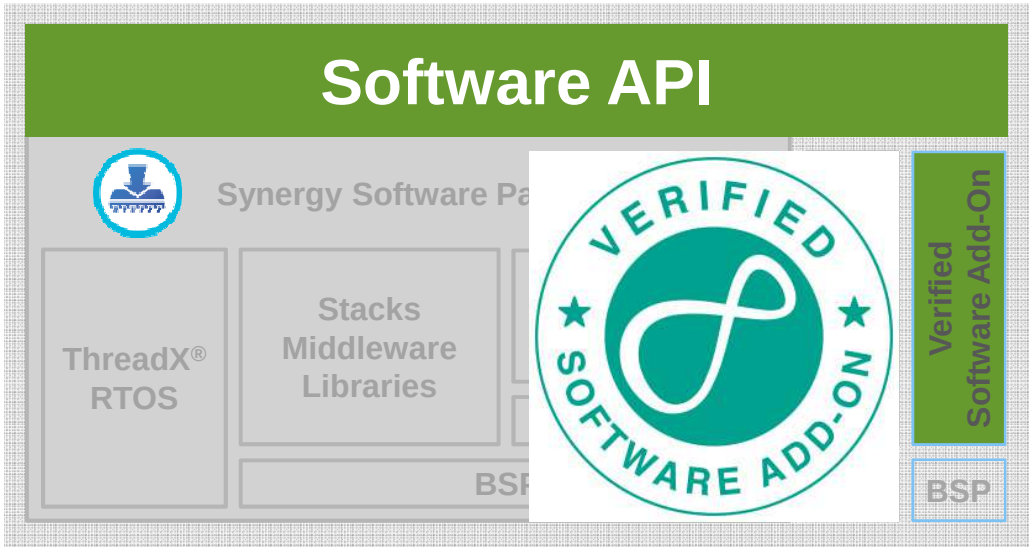


Verified Software Add-ons

How to access VSA's?

VSA evaluation software is downloaded from the Renesas Synergy™ Gallery.

VSA production software is licensed from the 3rd party software vendors.



VSA Compliance

Proven compatibility with Synergy platform per Renesas specifications.

Tested on Renesas hardware.

Documented Functionality: Test procedures and results provided.

Are VSA's chargeable?

Case by case.
VSA's can be free-of-charge or chargeable.
Depends on common software market pricing.

How are VSA's supported?

Synergy is supported by Renesas.
For VSA's, Renesas will support initial assessment and ensure the best possible source of support takes over.

Quality: How Renesas defines software as a product

Best Practices

Software Development Life Cycle (SDLC):

- Traceability.
- Coding standards.
- Code reviews.
- Continuous integration.
- Professional release process.

Industry Standards

Well-respected standards for software development:

- MISRA C:2012 compliant.
- ISO/IEC/IEEE 12207 – Software life cycle processes.
- CERT 2nd Edition – C Programming Language Secure Coding Standard.

Software Quality Assurance (SQA)

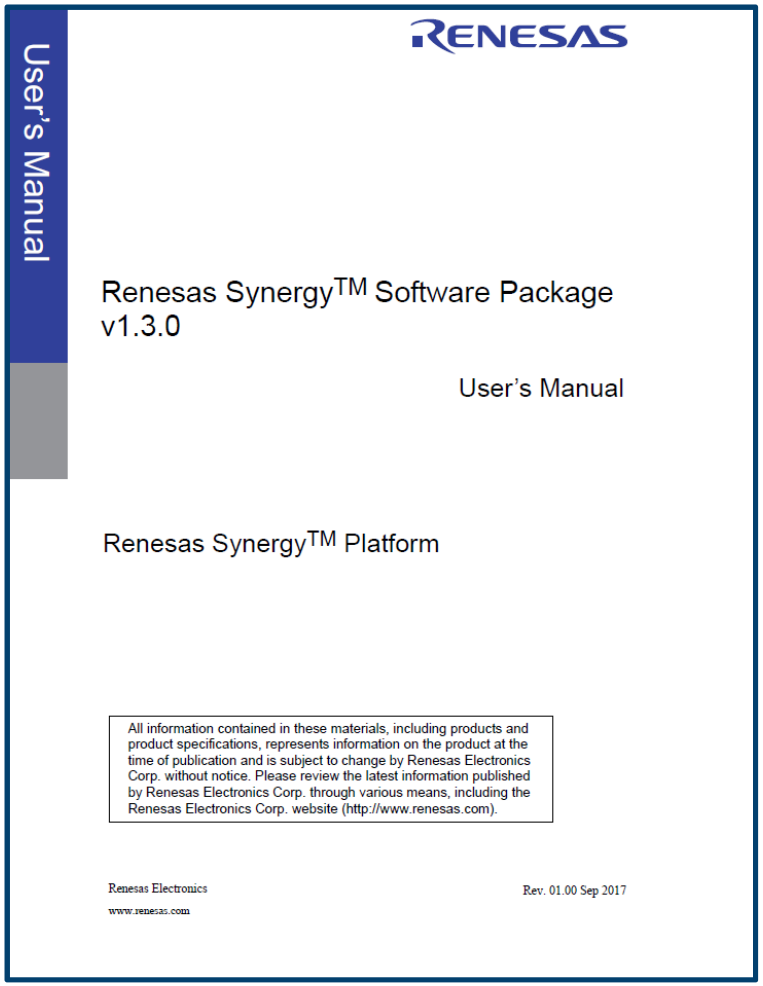
Established dedicated SDA team, also working with external auditing:

- Software Quality Assurance plan.
- Requirements traceability throughout development.
- SQA metrics & reports available to customers.

Subject to Change

Quality: Software data sheets

- **For Synergy Software Package (SSP) and QSA:**
- Published and maintained on Renesas Gallery.
- Specifications and performance metrics tested and documented.
- Benchmarks, code size, context switch times, latencies, execution times…
- Basis of SSP warranty



3488 pages !

Support: Renesas as single point of contact

Online Chat

- 24/5 technical support via online chat
- Renesas Synergy™ trained operators

Forum & FAQ

- Renesas Rulz moderated forum by Renesas Synergy specialist
- Renesas Synergy Platform Knowledge Database and FAQs

Smart Documentation

- Extensive Renesas Synergy Software & hardware documentation
- Wiki-based and Context aware

Application Engineers

- Application Engineers accessible via established sales routes

IDH network

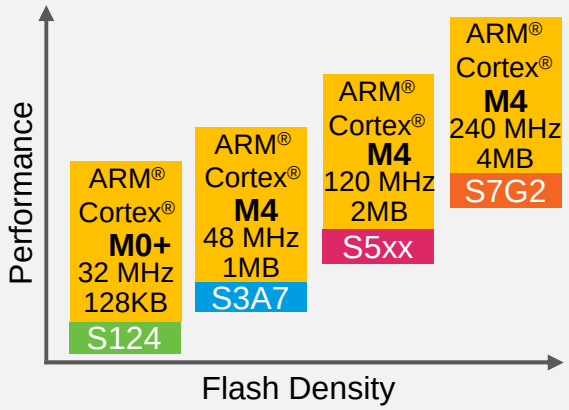
- From specific tasks to turn-key designs
- Often near you in local language

On-site Training

- On-site trainings of various scope and venues
- At customer site, distribution site or public

Renesas Synergy™ Microcontrollers

Technology



- Process:
  - S7 & S5 → 40nm, 2.7V-3.6V
  - S3 & S1 → 130nm, 1.6V-5.5V
- Operating temperature range:
  - -40°C to 105°C

Four Microcontroller Series

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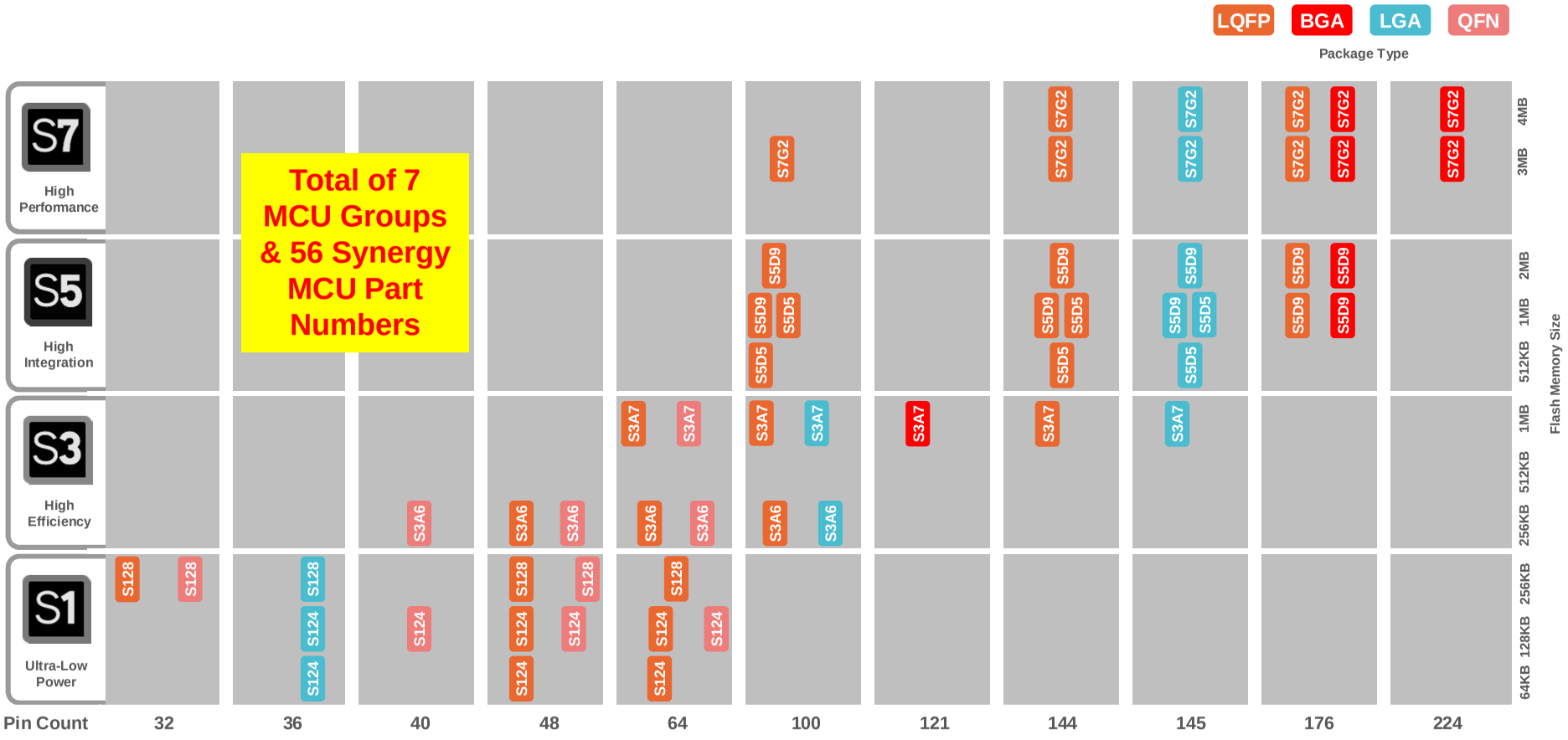
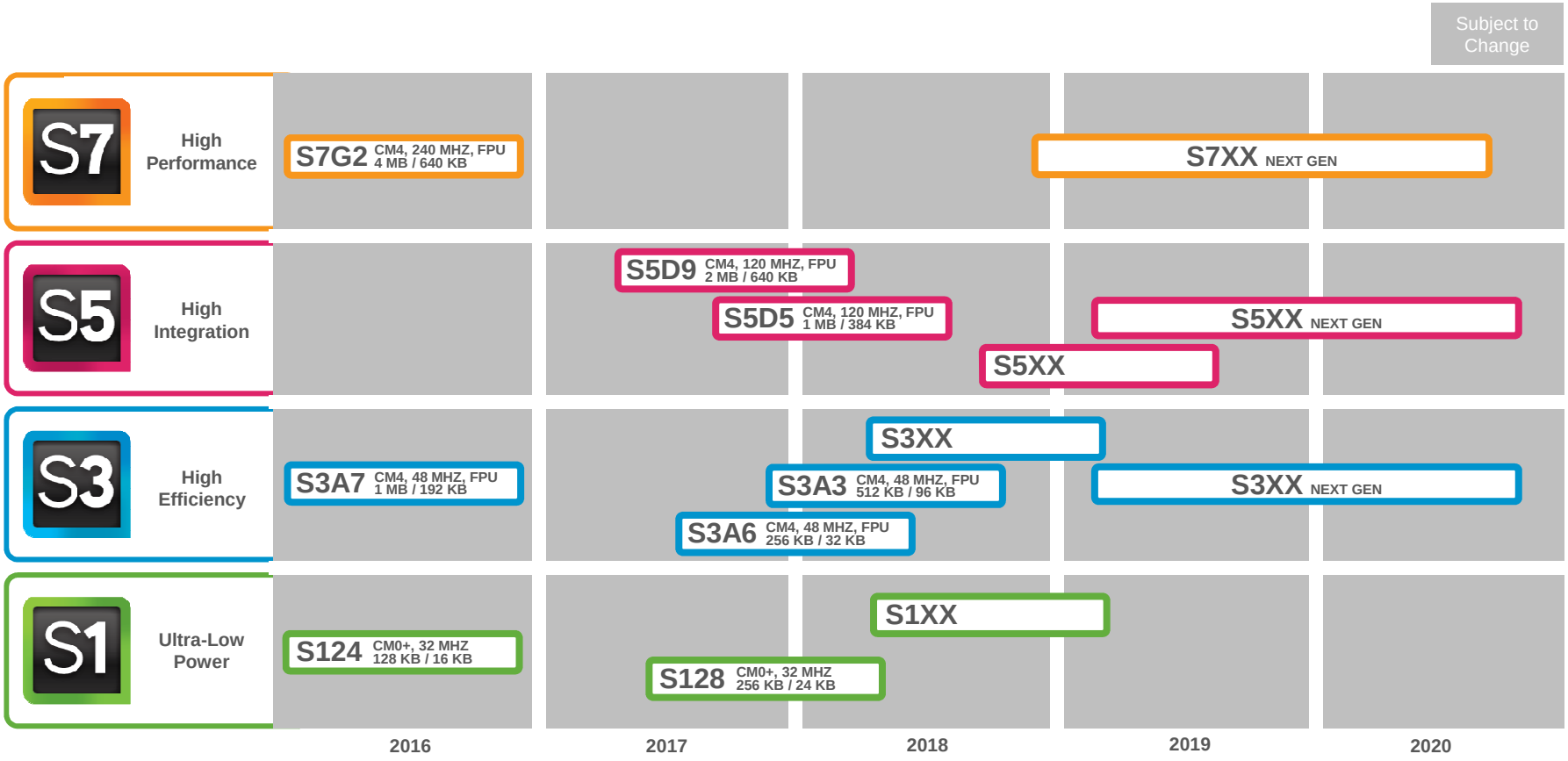
Synergy MCU Packages BY MCU Group

As of SEP 2017: S7G2, S5D9, S5D5, S3A7, S3A6, S128, S124 MCU Groups



Synergy Platform Roadmap

as Of Sep 2017: Includes MCU, SSP, Tools, Kits, Solutions



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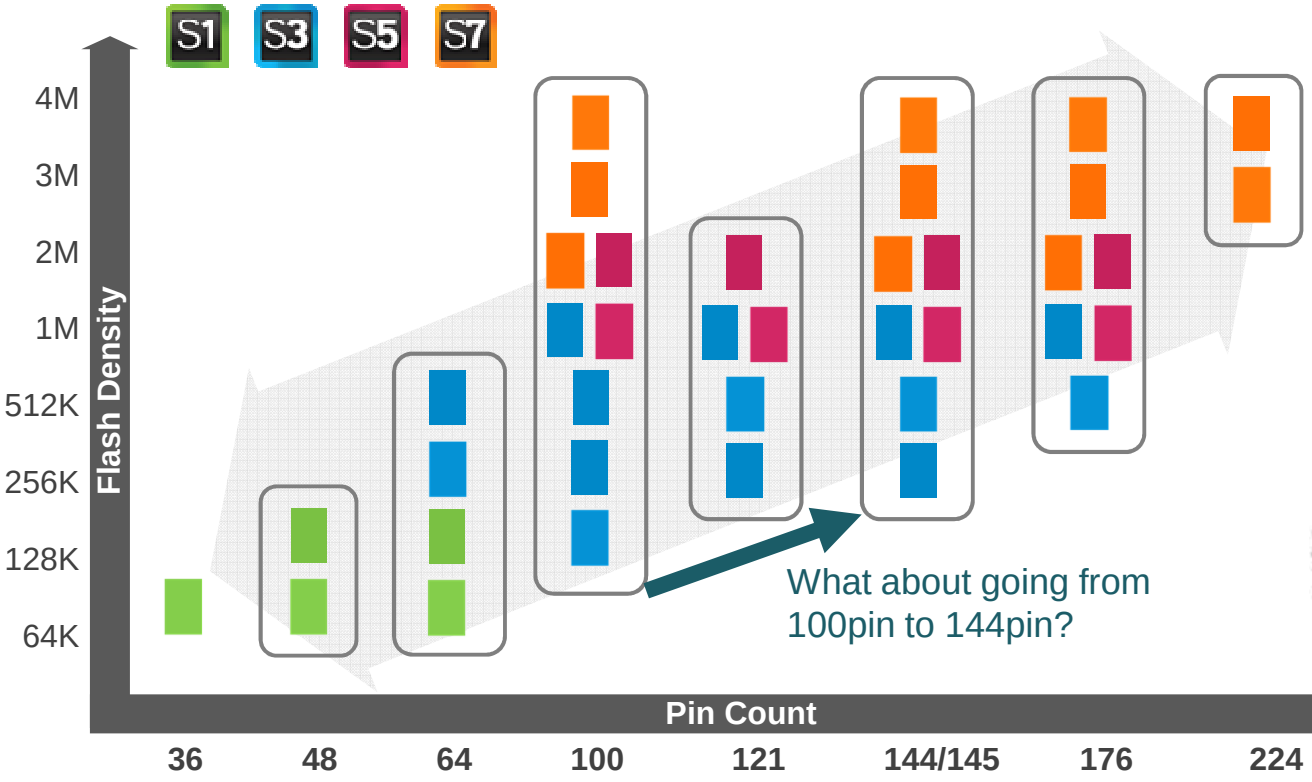
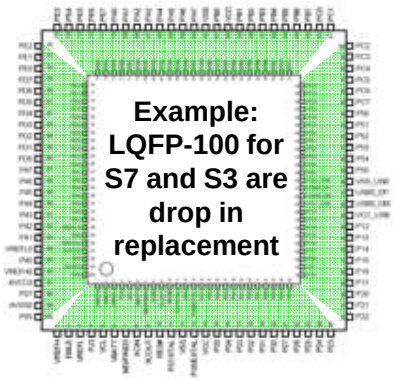
Microcontroller Portfolio

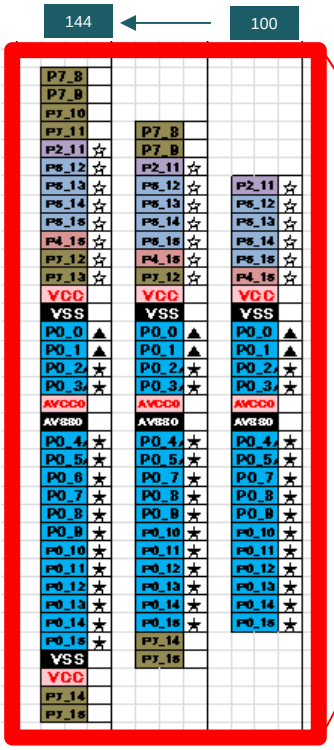


Peripheral and Pin Compatibility Across and Between Product Series

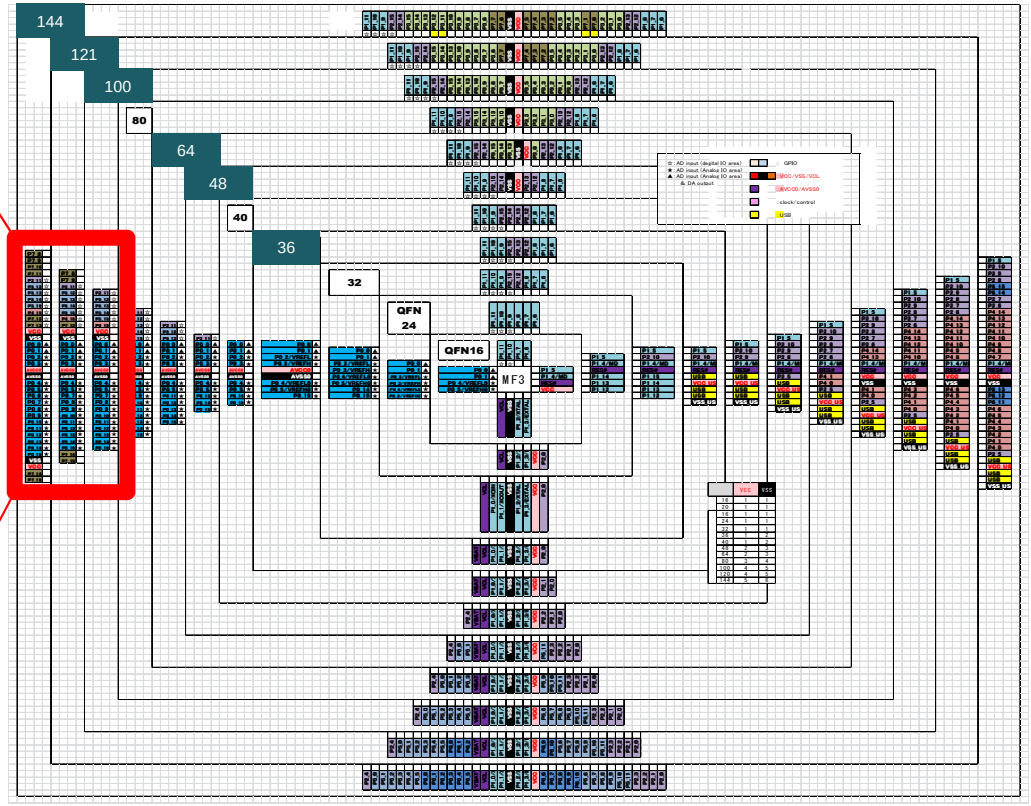


Synergy Has Scalable Pin-outs

Board rework minimized going from 100pin to 144pin package



Pin-outs for several Synergy packages



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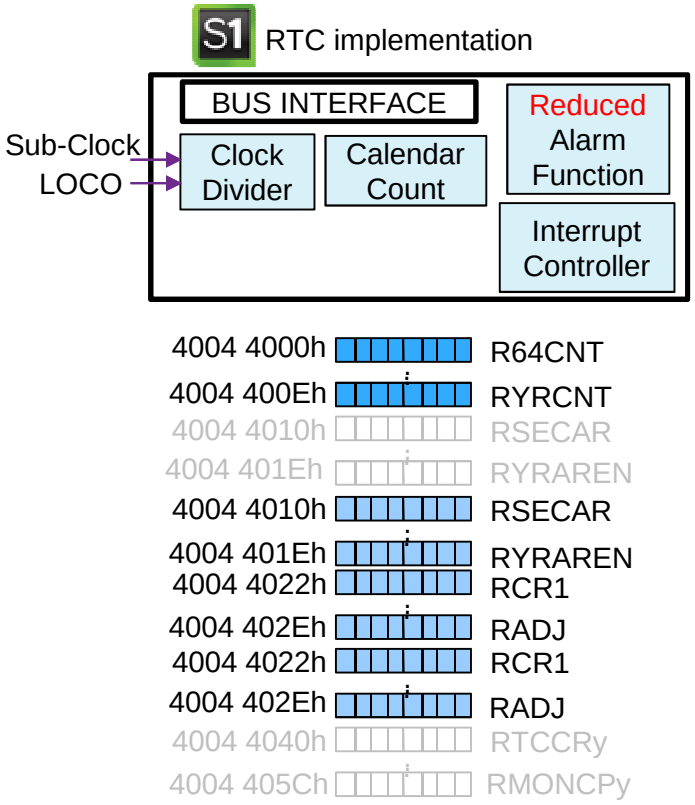
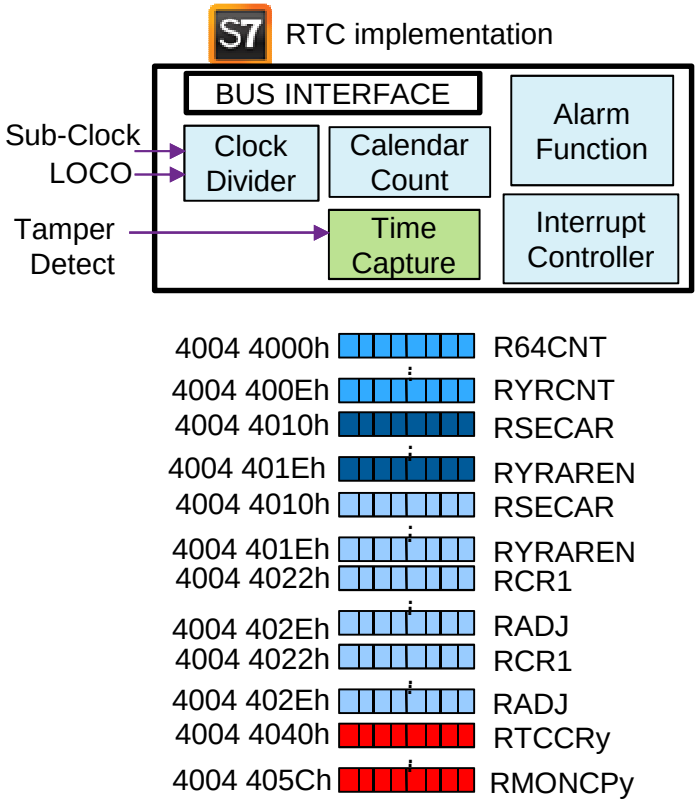
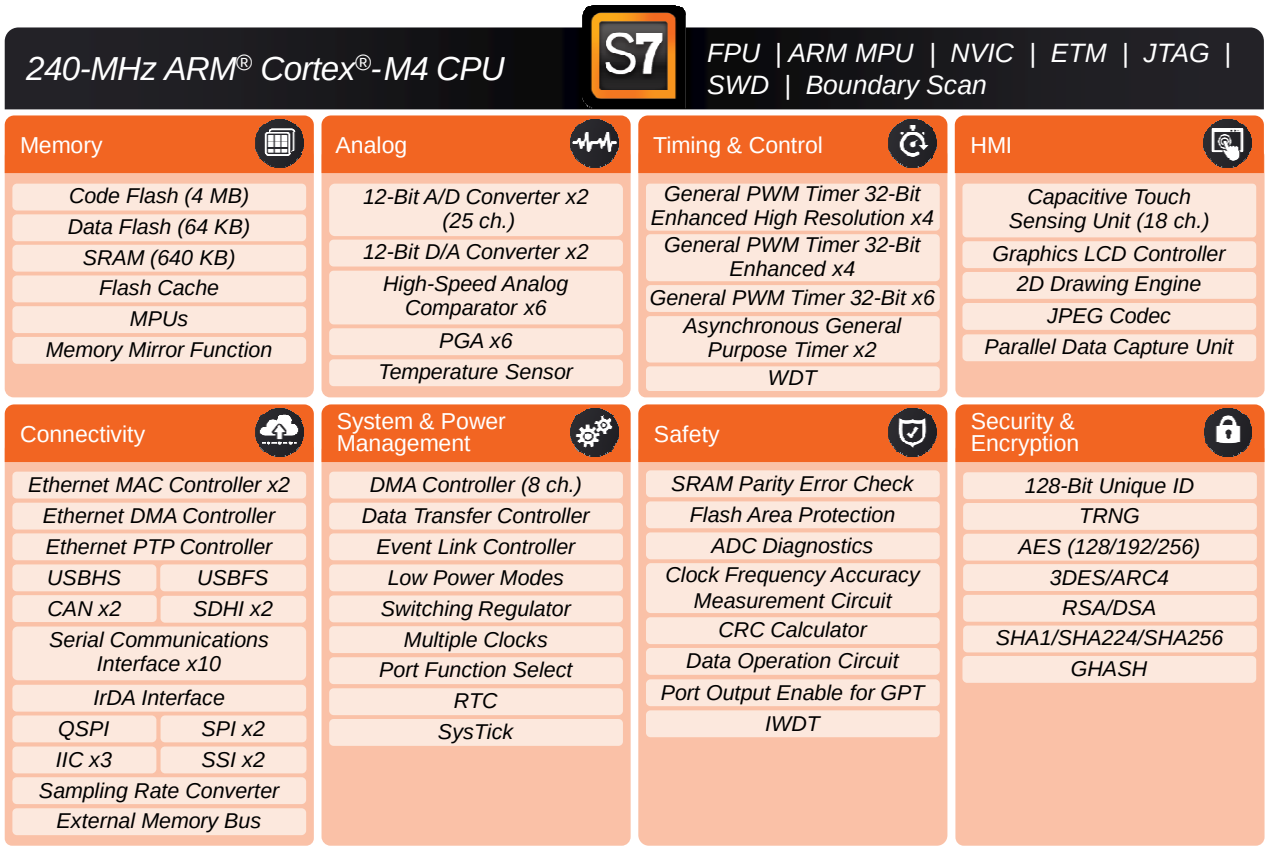
Synergy Has Scalable Peripherals





- Physical features of the peripheral in the S1 MCU is a pure orthogonal subset of the features in the S7 MCU
- The control registers have no dependencies as they are scaled down to a lower feature set
- The control register address offsets are constant even as features are removed

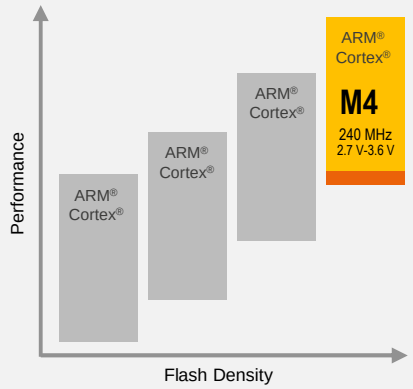
Synergy MCU S7 Series



Example - Synergy S7 Series MCUS – High End

S7

Technology



- 40-nm high-performance processes
- Operating temperature range: -40°C to 105°C
- GPIO pins: Up to 172
- Package LQFP: 100, 144, 176
- Package BGA: 176, 224
- Package LGA: 145

240 MHz ARM® Cortex®-M4 CPU — S7G2

FPU | ARM MPU | NVIC | ETM
JTAG | SWD | Boundary Scan

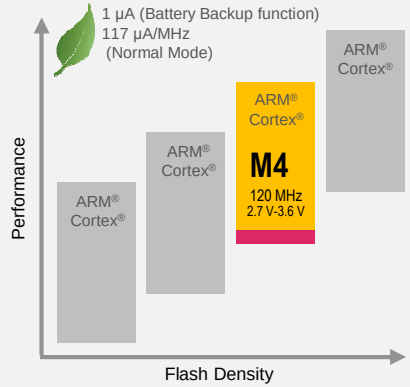
Memory	Analog	Timing & Control	HMI
Code Flash (4 MB)	12-Bit A/D Converter x2 (25 ch.)	General PWM Timer 32-Bit Enhanced High Resolution x4	Capacitive Touch Sensing Unit (18 ch.)
Data Flash (64 KB)	12-Bit D/A Converter x2	General PWM Timer 32-Bit Enhanced x4	Graphics LCD Controller
SRAM (640 KB)	High Speed Analog Comparator x6	General PWM Timer 32-Bit x6	2D Drawing Engine
Flash Cache	PGA x6	Asynchronous General Purpose Timer x2	JPEG Codec
MPUs	Temperature Sensor	WDT	Parallel Data Capture Unit
Memory Mirror Function			

Connectivity	System & Power Management	Safety	Security& Encryption
Ethernet MAC Controller x2	DMA Controller (8 ch.)	SRAM Parity Error Check	128-bit Unique ID
Ethernet DMA Controller	Data Transfer Controller	Flash Area Protection	TRNG
Ethernet PTP Controller	Event Link Controller	ADC Diagnostics	AES (128/192/256)
USBHS / USBFS	Low Power Modes	Clock Frequency Accuracy Measurement Circuit	3DES/ARC4
CAN x2 / SDHI x2	Multiple Clocks	CRC Calculator	RSA/DSA
Serial Communications Interface x10	Port Function Select	Data Operation Circuit	SHA1/SHA224/SHA256
IrDA Interface	RTC	Port Output Enable for GPT	GHASH
QSPI / SPI x2	SysTick	IWDT	
IIC x3 / SSI x2			
Sampling Rate Converter			
External Memory Bus			

Example - Synergy S5 Series MCUS – Mid Range

S5

Technology



- 40-nm high-performance process
- Operating temperature range: -40°C up to 105°C
- GPIO pins: up to 110
- Package LQFP: 100, 144
- Package LGA: 145

120 MHz ARM® Cortex®-M4 CPU **S5D5** FPU | ARM MPU | NVIC | ETM JTAG | SWD | Boundary Scan

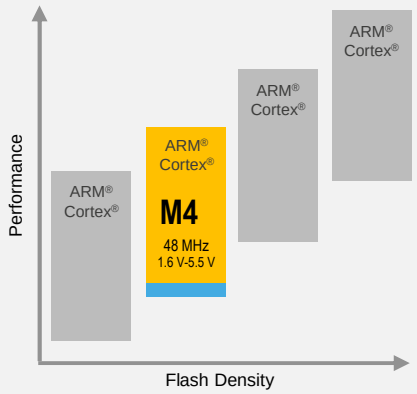
Memory	Analog	Timing & Control	HMI
Code Flash (512KB or 1 MB)	12-Bit A/D Converter x2 (22 ch.)	General PWM Timer 32-Bit Enhanced High Resolution x4	Capacitive Touch Sensing Unit (18 ch.)
Data Flash (32 KB)	12-Bit D/A Converter x2	General PWM Timer 32-Bit Enhanced x4	Parallel Data Capture Unit
SRAM (384 KB)	High Speed Analog Comparator x8	General PWM Timer 32-Bit x6	
Flash Cache	Temperature Sensor	Asynchronous General Purpose Timer x2	
MPUs		WDT	
Memory Mirror Function			

Connectivity	System & Power Management	Safety	Security& Encryption
Ethernet MAC Controller	DMA Controller (8 ch.)	ECC in SRAM	128-bit Unique ID
Ethernet DMA Controller	Data Transfer Controller	SRAM Parity Error Check	TRNG
USBFS Host/Device	Event Link Controller	Flash Area Protection	AES (128/192/256)
CAN x2 / SDHI x2	Low Power Modes	ADC Diagnostics	3DES/ARC4
Serial Communications Interface x10	Multiple Clocks	Clock Frequency Accuracy Measurement Circuit	RSA/DSA
IrDA Interface	Port Function Select	CRC Calculator	SHA1/SHA224/SHA256
QSPI / SPI x2	RTC	Data Operation Circuit	GHASH
IIC x3 / SSI x2	SysTick	Port Output Enable for GPT	
Sampling Rate Converter		IWDT	
External Memory Bus			

Example - Synergy S3 Series MCUS – Mid Range

S3

Technology



- 130-nm processes
- Operating temperature range: -40°C to 105°C
- GPIO pins: Up to 84
- Package LQFP: 48, 64, 100
- Package LGA: 100
- Package QFN: 40, 48, 64

48 MHz ARM® Cortex®-M4 CPU | S3A6 | FPU | ARM MPU | NVIC | ETB | JTAG | SWD | Boundary Scan

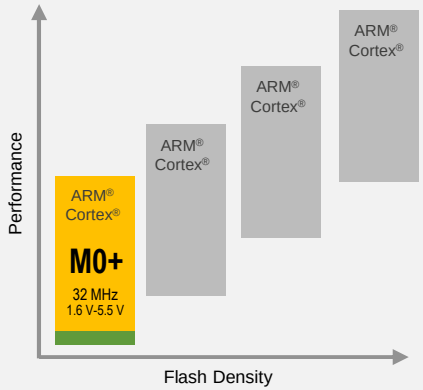
Memory	Analog	Timing & Control	HMI
Code Flash (256 KB)	14-Bit A/D Converter (28 ch.)	General PWM Timer 32-Bit x2	Capacitive Touch Sensing Unit (27 ch.)
Data Flash (8 KB)	12-Bit D/A Converter	General PWM Timer 16-Bit x6	Segment LCD Controller
SRAM (32 KB)	Low-Power Analog Comparator x2	Asynchronous General Purpose Timer x2	
Flash Cache	OPAMP x4	WDT	
Memory Protection Unit	Temperature Sensor		

Connectivity	System & Power Management	Safety	Security& Encryption
USBFS	DMA Controller (4 ch.)	ECC in SRAM	128-Bit Unique ID
CAN / SDHI/ MMC	Data Transfer Controller	SRAM Parity Error Check	TRNG
Serial Communications Interface	Event Link Controller	Flash Area Protection	AES (128/ 256)
QSPI / SPI x2	Low Power Modes	ADC Diagnostics	GHASH
IIC x2 / SSI	Multiple Clocks	Clock Frequency Accuracy Measurement Circuit	
	Port Function Select	CRC Calculator	
	RTC	Data Operation Circuit	
	SysTick	Port Output Enable for GPT	
	Low Voltage Detection	IWDT	

Example - Synergy S1 Series MCUS – Low End

S1

Technology



- 130-nm processes
- Operating temperature range: -40°C to 105°C
- GPIO pins: Up to 51
- Package QFN: 40,48,64
- Package LQFP: 48, 64
- Package LGA: 36

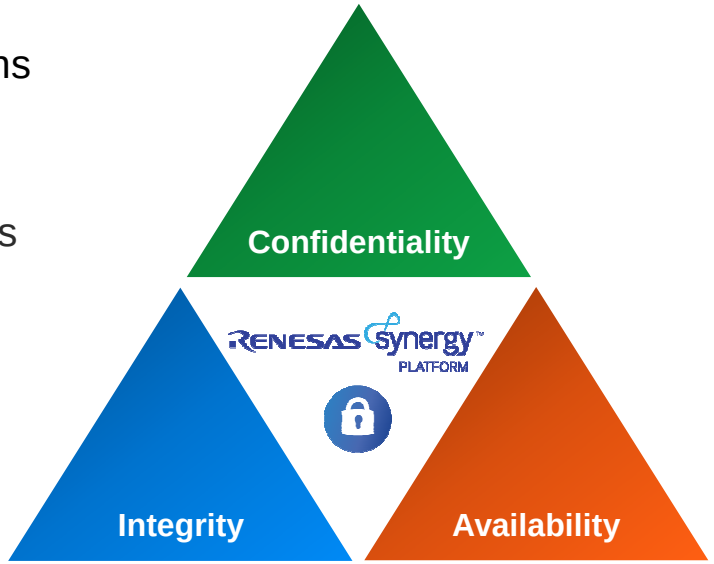
32 MHz ARM® Cortex®-M0+ CPU | S124 | NVIC | SWD | MTB

Memory	Analog	Timing & Control	HMI
Code Flash (up to 128 KB)	14-Bit A/D Converter (18 ch.)	General PWM Timer 32-Bit	Capacitive Touch Sensing Unit (31 ch.)
Data Flash (4 KB)	12-Bit D/A Converter	General PWM Timer 16-Bit x6	
SRAM (16 KB)	Low-Power Analog Comparator x2	Asynchronous General Purpose Timer x2	
	Temperature Sensor	WDT	

Connectivity	System & Power Management	Safety	Security& Encryption
USBFS	Data Transfer Controller	SRAM Parity Error Check	128-Bit Unique ID
CAN	Event Link Controller	Flash Area Protection	TRNG
Serial Communications Interface x3	Low Power Modes	ADC Diagnostics	AES (128/ 256)
SPI x2	Multiple Clocks	Clock Frequency Accuracy Measurement Circuit	
IIC x2	Port Function Select	CRC Calculator	
	RTC	Data Operation Circuit	
	SysTick	Port Output Enable for GPT	
		IWDT	

Synergy Enabling Confidentiality, Integrity & Availability

- Enabling **confidential** data and secure authentication
  - World class cryptography for secure communications
  - Secure authentication and identification
- Delivering platform **integrity** to enable trusted services
  - Root of trust to manage keys securely
  - Isolation of critical code to restrict attacks
  - Authenticated boot capability
  - Secure JTAG (Debug) access
- Safeguarding critical system **availability**
  - Isolation of critical system to help ensure uptime
  - Management of applications & system behaviour
  - Lifecycle management & secure updates



IDE vs. Synergy ISDE – New Age Development Environment

\+

= **ISDE**

IDE

Integrated Development Environment

Solution-oriented components

Integrated Solutions Development Environment

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Renesas Synergy™ Tools

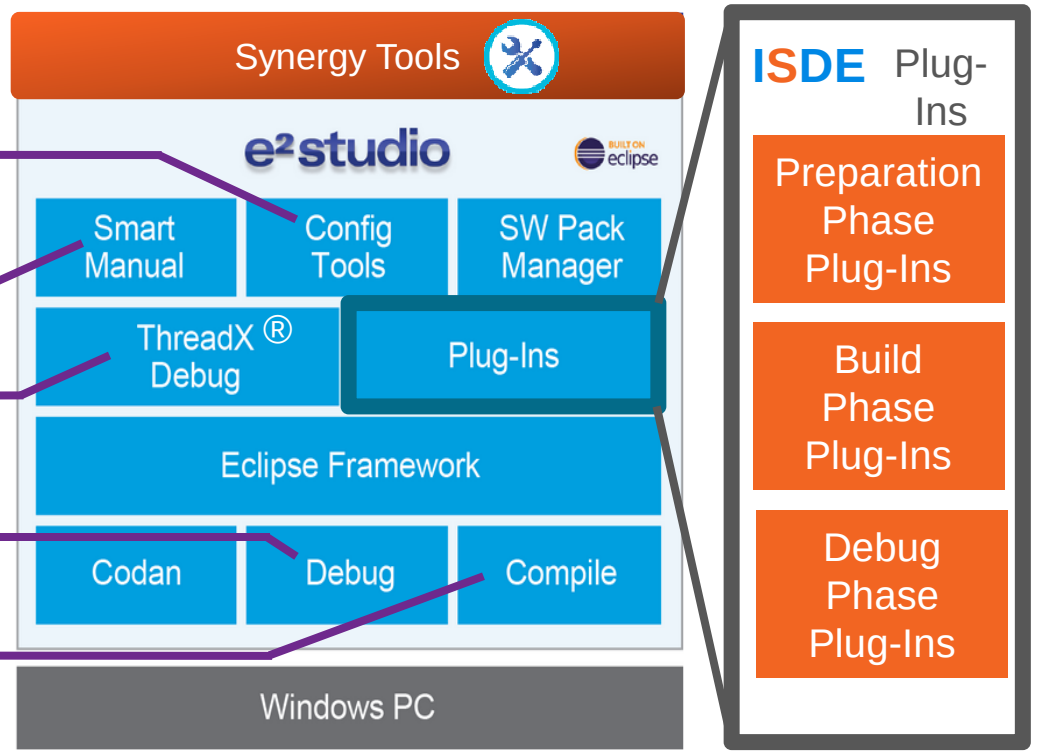
Configuration Tools
Within the ISDE there is a Pin Configurator (includes Package View), Clock Configurator, Interrupt Control Unit (ICU) Configurator, and SSP Module Selector/Configurator.

Smart Manual
There are Smart Manuals for the MCUs and SSP. The SSP Secure Source can be viewed.

ThreadX® Debug
Built-in ThreadX® RTOS awareness, ThreadX® Execution Profile Kit (EPK), TraceX® support, and GUIX™ Studio support.

Debug
There is integration for Segger J-Link and a debug viewer for the SSP Secure Source.

Compile
Both the GNU ARM tool chain and the IAR ARM tool chain have been integrated.



Synergy MCU Smart Manual is within the e² studio ISDE

```
int main(void)
{

    while (1) {
        SYSTEM.SCK1.BYTE = 0;
    }
  return 0;
}
```

Highlight the MCU register name…

…brings up detailed information…

Synergy Software Smart Manual is within the e² studio ISDE

```
 * @retval  AMS_ERR_QUEUE_UNAVAILABLE  Cannot open s/w queue
 * @retval  AMS_ERR_NULL_PTR      Null pointer is(are) given
 * @retval  AMS_ERR_INTERNAL      Internal error occurs
 * @note This function is reentrant for any channel.<br>
 * @note Handle must be cleared by caller before calling this function.
 ***********************************************************************************************
ams_err_t AMS_UART_Open (ams_uart_dev_t * const p_dev, ams_uart_cfg_t * const p_cfg)
{
    ams_err_t   err;
    drv_uart_cfg_t tmp_lower_lvl_cfg;

    /** (1) Checks error. Further parameter checking can be done at the driver layer. */
#ifdef AMS_UART_CFG_PARAM_CHECKING_ENABLE
    if ((NULL == p_dev) || (NULL == p_cfg))
    {
        return AMS_ERR_NULL_PTR;
    }
    if (((((NULL == p_cfg->p_lower_lvl_api->open)
        || (NULL == p_cfg->p_lower_lvl_api->close))
```

Highlight the API name…

…brings up detailed information…

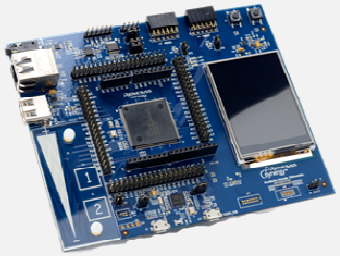
Name: AMS_UART_Open
Prototype: AMS_UART_Open (ams_uart_dev_t *const p_dev, ams_uart_cfg_t *const p_cfg)
Description:

This is one of AMS UART framework driver API, which opens a designated UART channel.
UART framework driver, Open API. The open API acquires mutex/event flag objects and handles driver initialization at UART HAL layer.

Parameters:
p_dev - Handle for UART driver context for a channel(Value returns from this function). This value must be cleared by user.
p_cfg - UART configuration includes UART interface information which includes channel and API

Parameters:
AMS_SUCCESS - UART channel is successfully opened
AMS_ERR_BAD_CHAN - Illegal UART channel is specified
AMS_ERR_OMITTED_CHAN - Omitted UART channel is specified
AMS_ERR_CH_NOT_CLOSED - UART channel have already been opened
AMS_ERR_BAD_MODE - Unsupported or incorrect mode
AMS_ERR_INVALID_ARG - Argument is not one of the predefined values

Renesas Synergy™ Kits

Parameters	Target Board (TB)	Starter Kits (SK)	Development Kits (DK)
Footprint			
Purpose	MCU sample on PCB	Synergy Platform introduction and first steps	Complete project prototyping
MCU Pin Access	All pins	Most Pins	All Pins
Expandability/Connectors	Pmod footprint	Arduino and Pmod	Expansion and Pmod
SSP Qualification Basis	Limited	Yes	Yes
BLE Connectivity	✗	✓	Most
On-board J-Link® Debugger	✓	✓	✓
Suggested Retail Price	Low cost, about 30 USD	Typically less than a hundred USD	Typically a few hundred USD

Renesas Synergy™ Solutions

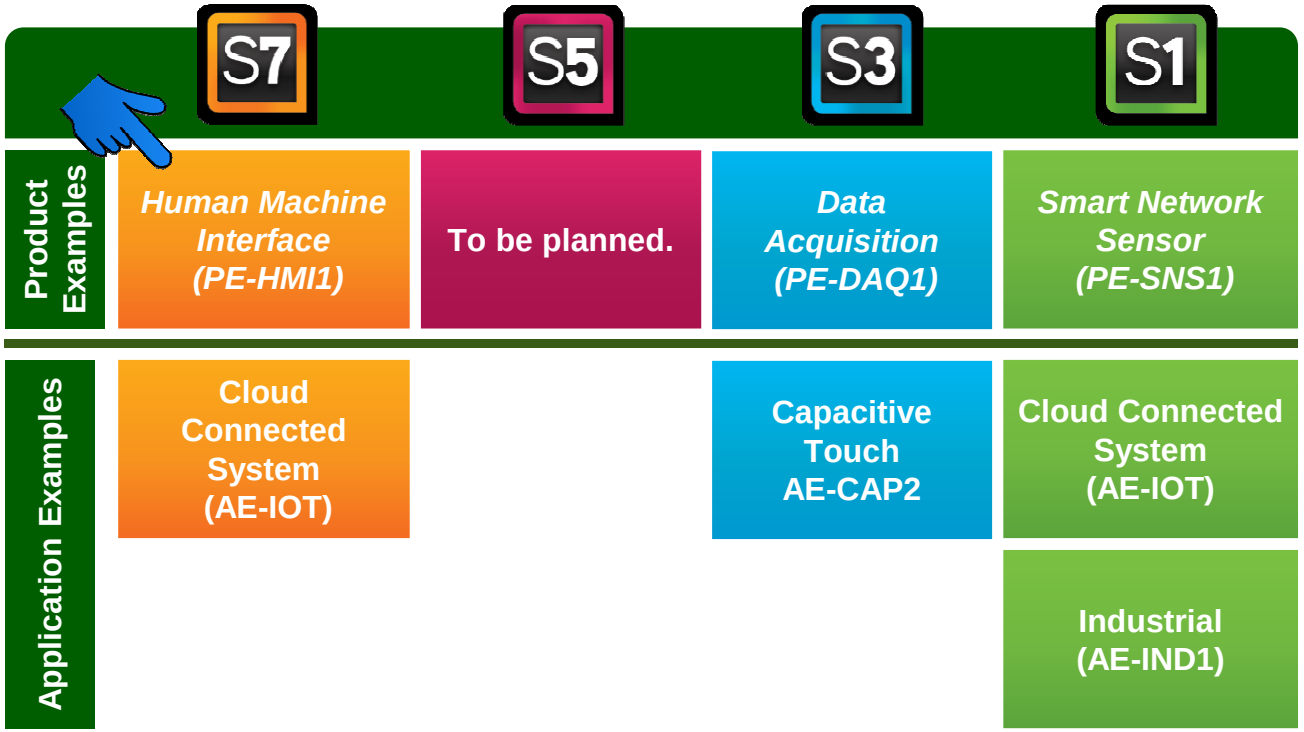
Starting points that you can count on

Product Examples

- Custom hardware which is a design instance of an end product
- Contains design journey document describing design considerations
- Includes e²studio project, BOM, schematics, and board layout files

Application Examples

- Example code running on standard Renesas Synergy hardware kit showcasing specific hardware and software components
- Contains Application Note document
- Includes e²studio project



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HMI Product Example

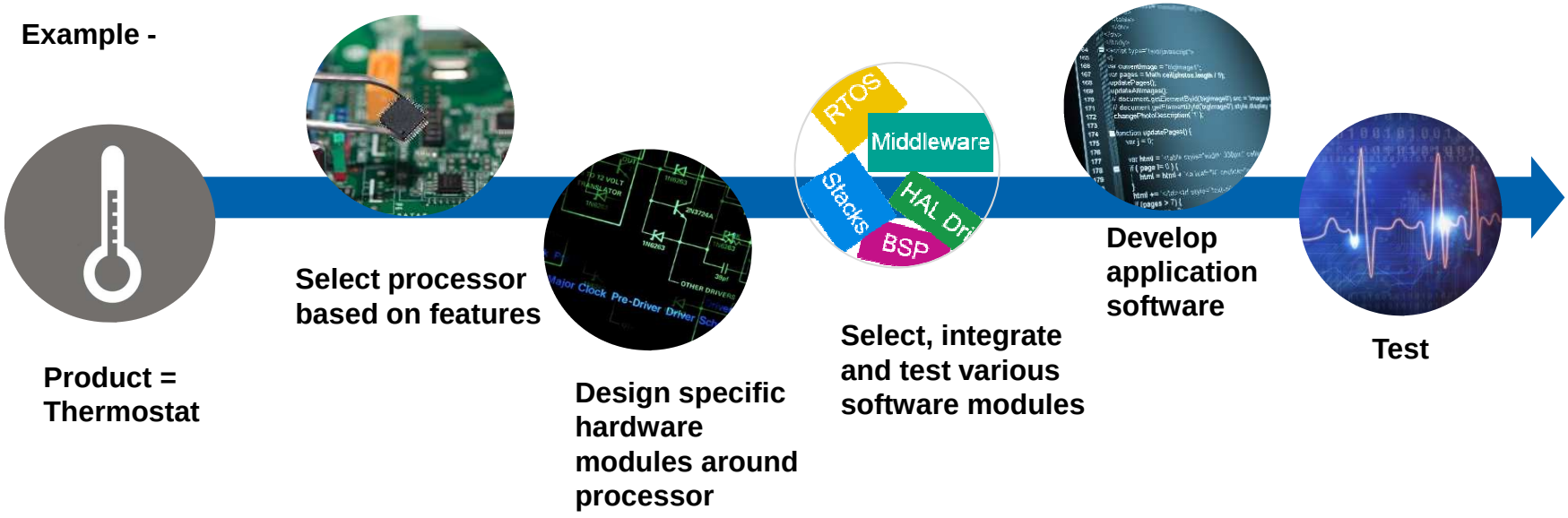
- Represents one design instance of an HMI product
- PE + design journey documentation = jump start for application
- Reference platform to show graphics performance of S7G2 MCU + SSP
- Software demo thermostat
  - Extension to include audio framework for alarm sound
  - Extension to include a Pmod peripheral
  - Extension to control backlight using the ambient light sensor ALS

PE-HMI1 Kit
Human Machine Interface

Platform-Based Development

Typical Embedded Development Process Today

Focused on features, hardware design, software integration



Focus is on development process

Synergy Changes the Development Process

Focus shifts to product experience and added value

Instead -

How will my customer use their thermostat?

Synergy Product

HMI & Connectivity is important for this application!

RENESAS synergy™ PLATFORM

Software, stacks ready and available!

Develop application software

Focus is on customer's product experience, product innovations

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Summary

Summary

The only fully qualified Microcontroller platform solution available today

- Fully qualified, integrated and professional software platform design to work on synergy microcontrollers
- You can download it and use it today, with no upfront or license costs

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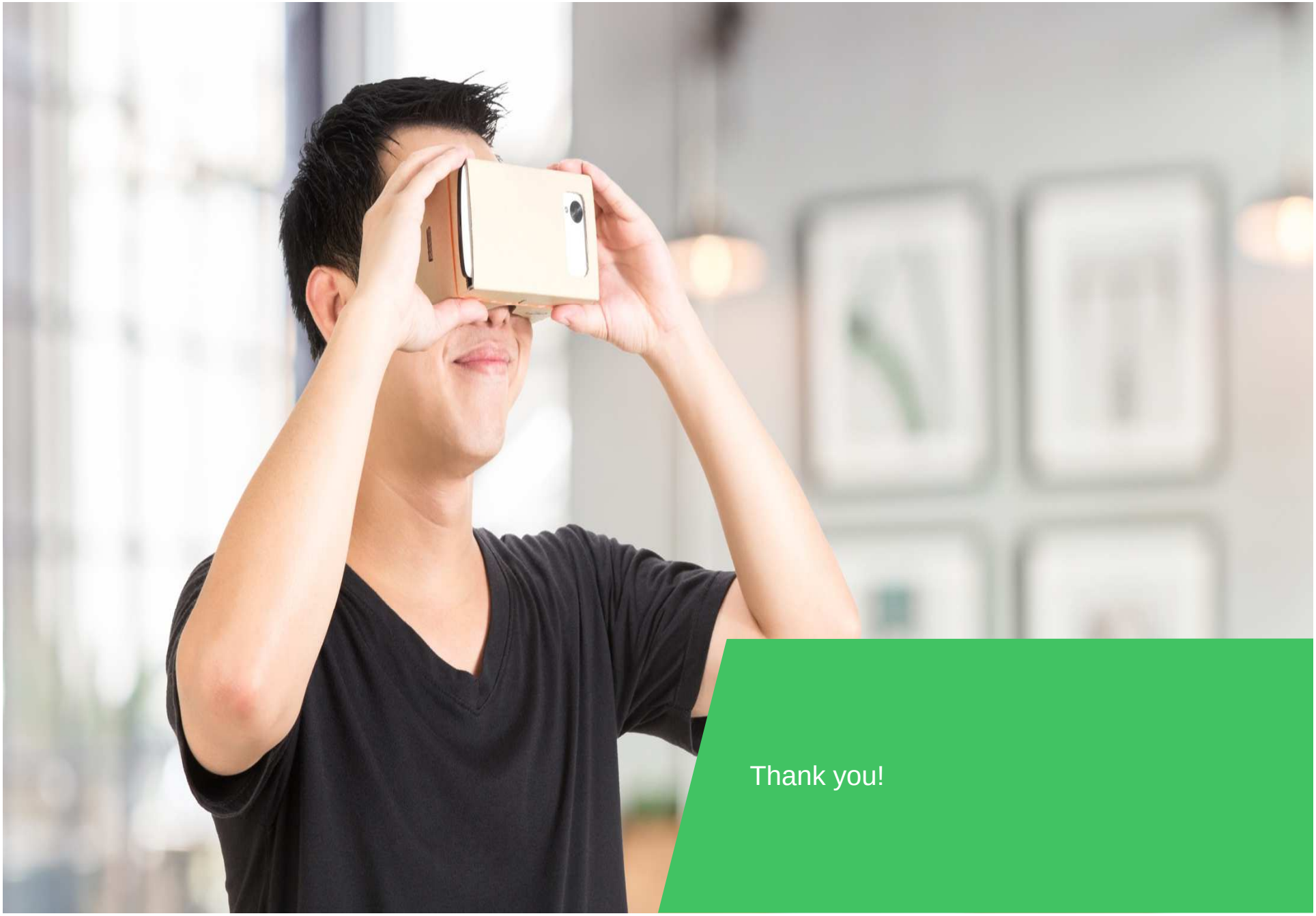
Thank you!