Yocto and Device Tree Management

for Embedded Linux Projects

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Agenda

Yocto and Device Tree Management for Embedded Linux Projects

The Yocto Project

- Introduction
- Ecosystem and Partnerships
- Advantages: Community and System
- Device Tree

PHYTEC and Yocto

- Unified Board Support Packages (BSPs)
- Release Management, Meta Data and BSP Software Components
- PHYTEC Linux Script
- About PHYTEC

The Yocto Project

Introduction

Yocto is:

- Open-source Project to make Embedded Linux Development Easier
- Templates, Tools, Methods for custom Linux regardless of platform
- Build System=Bitbake+Metadata as a core project component
- Community & Industry sponsored and backuped

For those of you who are wondering about the name, the term *yocto* is the smallest SI unit. As a prefix, yocto indicates 10^-24.

The Yocto Project

Ecosystem and Participants

gumstix dream. design. deliver
LONG TERM SUPPORT INITIATIVE
EXPEMB 360
wolfSSL
BEC SYSTEMS
DOULOS EMBEDDED
fluentd
Q technology
MontaVista
chargestorm
dynamicDevices
Emsys
Ångström
ALICO SYSTEMS INC
garcia lasheras
KOAN
sleep(5)
AMD
intel
RENESAS
SDG SYSTEMS
net Module
LG
openembedded
freescale semiconductor
Sidebranch
ENEA
LINUTRONIX
BROADCOM.
CIO INFORMATIQUE INDUSTRIELLE
move innovation
bytes at work
Mentor Graphics
DELL
denx software engineering
TEXAS INSTRUMENTS
HUAWEI
EUKREA electromatique
SAKOMAN INC
SILICA An Avnet Company
WIND
HTTP MONKEY-PROJECT.COM
LSI Storage. Networking. Accelerated.
JUNIPER NETWORKS
timesys Embedded Linux from a Trusted Source
ellexus
Free Electrons

The Yocto Project

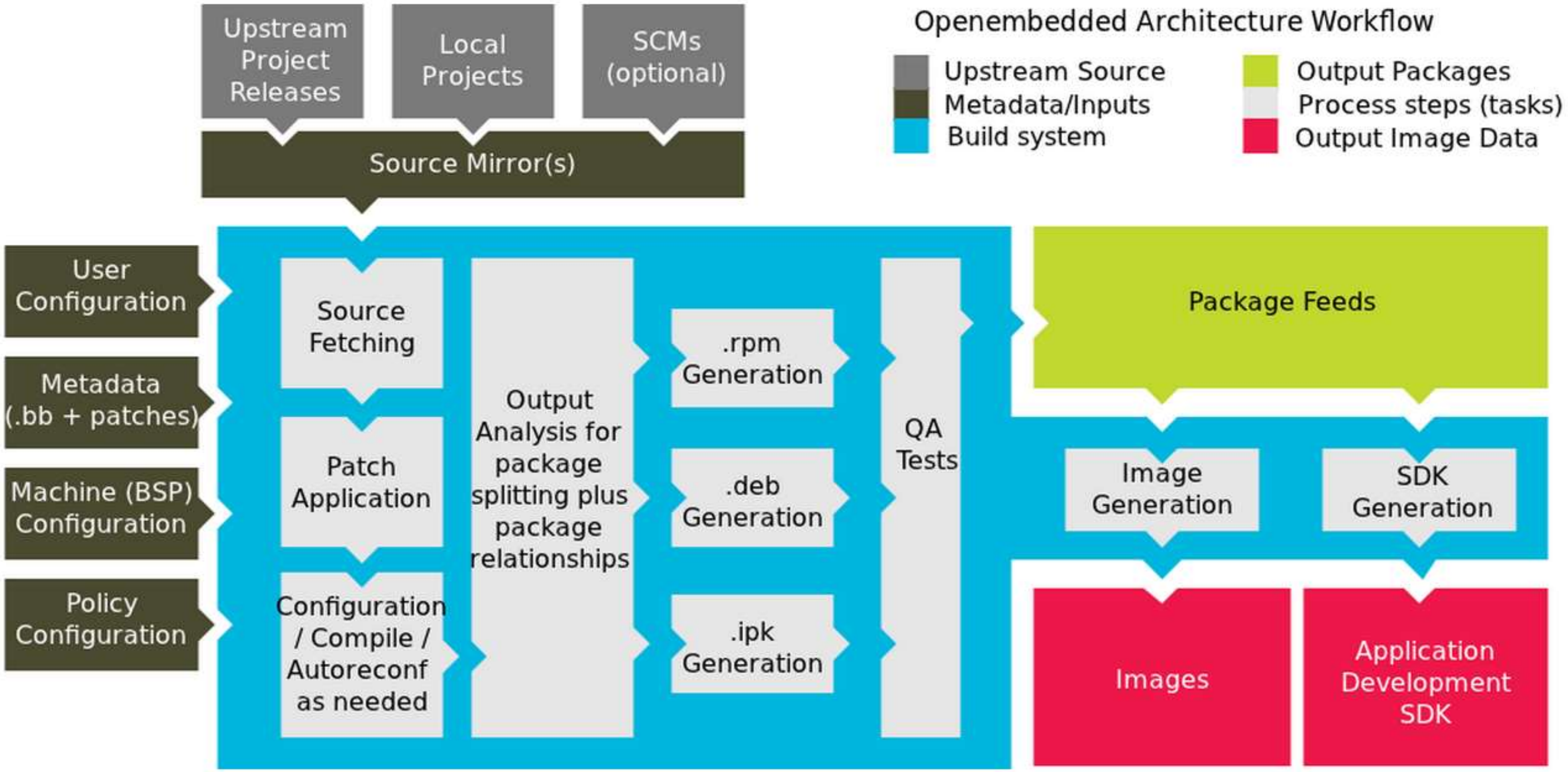
Core Components-build System

BitBake: the build engine-task scheduler & executor
OpenEmbedded-Core: a set of base layers
Layers: Collection of metadata to abstract specific functionality and fulfill a specific purpose
Metadata: Task Definition-what & how to build

- Recipes (.bb): the logical units of software/images to build
- Classes (.bbclass): abstraction to common code(task)
- Configuration files (.conf): global definitions of variables (eg. Machine achetechture, file path)

The Yocto Project

Build System workflow

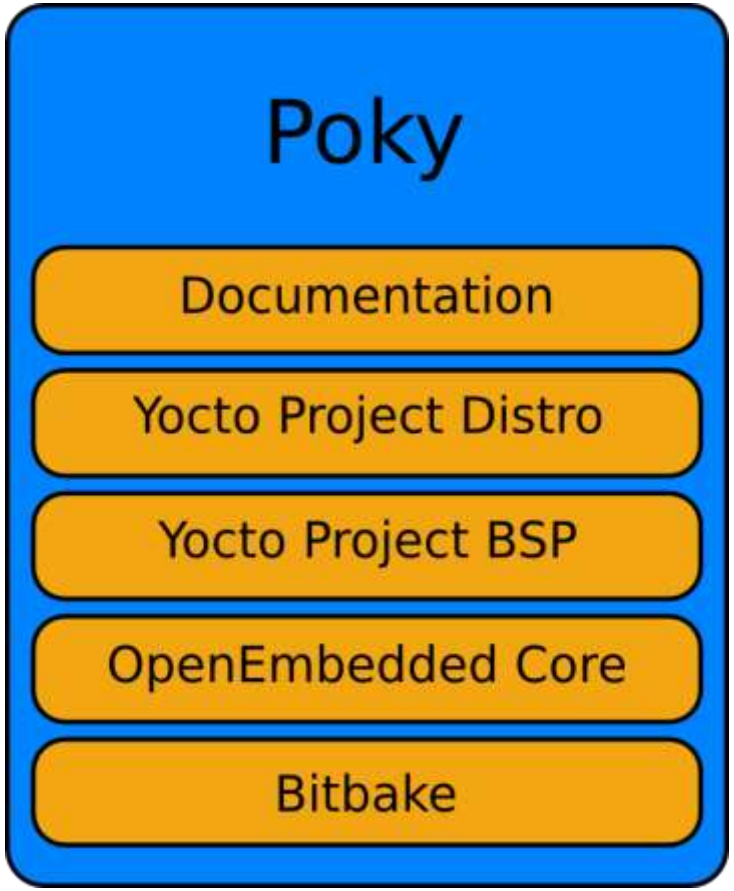


Source:http://www.yoctoproject.org/docs/1.8/mega-manual/mega-manual.html

The Yocto Project

Poky-the reference build system

- Poky is a reference system of the Yocto Project
- Poky contains tools, OE-Core, a BSP and other software package or layers to run the build.
- Poky offers Starting Point to create your own build
- Modular design makes it easy to reuse/customize the layers and integrate third party tools
- Includes many technologies and features such as
    - GNOME Mobile
    - Gstreamer
    - OpenGL
    - …much more



The Yocto Project

Development based on Yocto

- YOCTO maintain up-to-date baseline/reference build system
- SOC/Silicon vendors provide/add support on, reference BSP with SOC/EVM specific layer
- SOM/BOARD vendors add supports reference BSP with BOARD specific layer
- Third Party software/package provide can add supports at software package layer
- OSV/System integrator/application device manufacturer can add support on & integrate all resources to build a commercial distro, and based on which develop commercial application products

The Yocto Project

Advantages

Well Managed common build system regardless of hardware platform:

- Start with a validated collection of software (toolchain, kernel, user space)
- Supports all major embedded architectures
- Rich documentation, guideline with reference for familiarization
- Save time learning and setting up new development environment (for app developer & sys developer)

Modular design encourages modular development, reuse, and easy customizations

- Developers may leverage and expand on existing Yocto Project layers
- Software projects, contained in layers, can be easily ported between distributions
- Separation of BSP, application, and software packages allow development to be distributed

Device Tree

Stucture

Simple Tree of nodes and properties

- Define pinout and layout of connections
- Describe the configuration of peripherals and active components
- Describes interrupt controllers and IRQs

Used by the Linux kernel and barebox

Device Tree

Stucture – Example of defining a UART

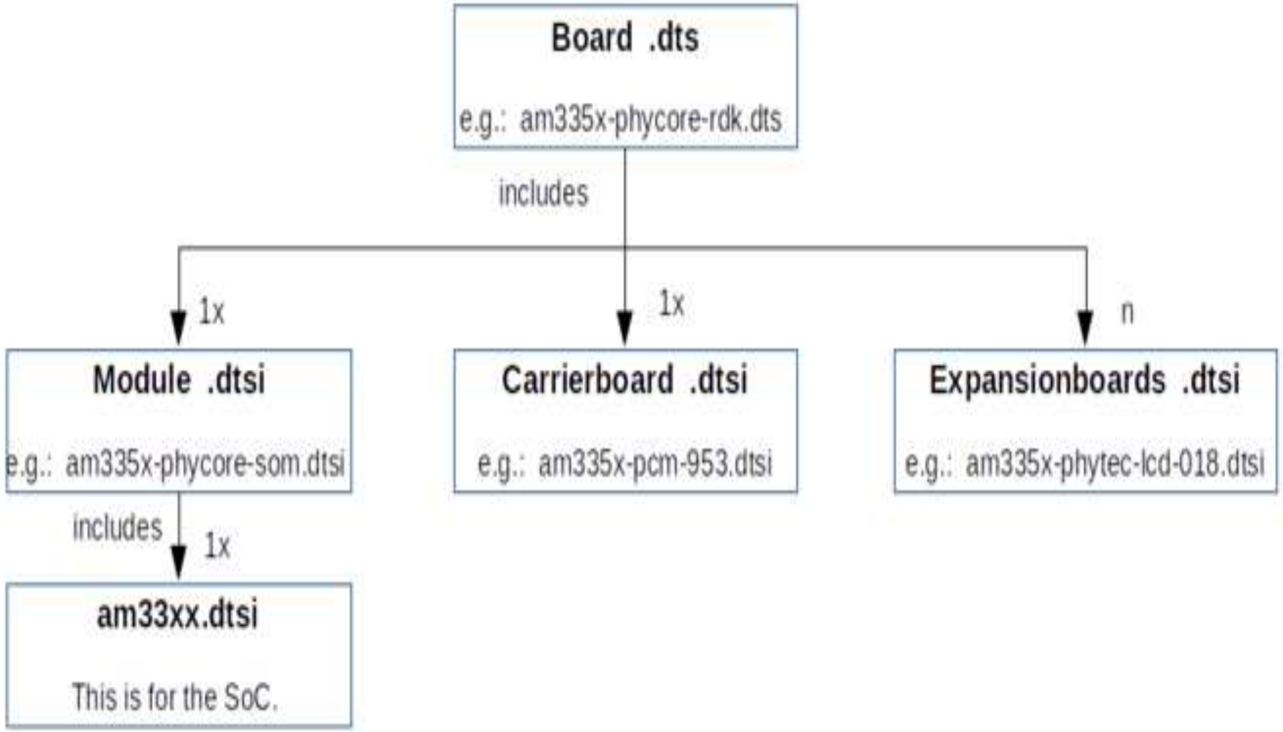
```
auart0: serial@8006a000 {
        Defines the "programming model" for the device. Allows the
        operating system to identify the corresponding device driver.
        compatible = "fsl,imx28-auart", "fsl,imx23-auart";
        Address and length of the register area.
        reg = <0x8006a000 0x2000>;
        Interrupt number.
        interrupts = <112>;
        DMA engine and channels, with names.
        dmas = <&dma_apbx 8>, <&dma_apbx 9>;
        dma-names = "rx", "tx";
        Reference to the clock.
        clocks = <&clks 45>;
        The device is not enabled.
        status = "disabled";
};
```

Taken from arch/arm/boot/dts/imx28.dtsi

Device Tree

Example – ARM SoC Development Kit

- A separate Device Tree include file (.dtsi) is created for each hardware platform such as (for PHYTEC):
  - System on Module
  - Carrier Board
  - Expansion Board
- Leverage existing SoC dtsi file from SoC vendors
- All Expansion Board configurations are included in the tree
  - Example: LCD display, WiFi module



Device Tree

Advantages

- Maintain many device trees for one kernel
- Possible to update the kernel without requiring changes to the DTS
- Many product configurations can be supported with no duplication of code
- Change DTS configuration without recompiling the Linux kernel
- DTS can easily be adapted for new hardware revisions
    - Minimizes development needed for life-cycle management
- Easier for hardware developers to adjust the OS support without touching Linux driver code

Yocto and PHYTEC

Yocto Support in PHYTEC Linux Board Support Packages (BSPs)

PHYTEC “Unified BSPs”: differentiated by specific processor families supported across various PHYTEC board-level platforms such as:

- phyCORE-AM335x
- phyFLEX-AM335x
- phyCARD-AM335x
- phyBOARD-AM335x (Wega, Rana)

PHYTEC Unified Yocto BSPs consist of three parts:

- Release Management
- Meta Data
- BSP Software Components

Yocto and PHYTEC

Yocto Support in PHYTEC Linux Board Support Packages (BSPs)

Release Management: Releases are managed with the “Repo” tool

- PHYTEC publishes approximately two releases per year and per processor-specific board-level platforms
- The release numbers are comprised of:
  - <processor type>-PD<year>.<number>.<patch number>
  - Example, AM335x-PD15.1.0 = first release for AM335x in 2015 with no applied service patches

Yocto and PHYTEC

Yocto Support in PHYTEC Linux Board Support Packages (BSPs)

Meta Data:

- Consists of all the information on how to build software packages
- Describes which bootloader and kernel is used for PHYTEC hardware platforms
- Source code for the software components itself is not included in the meta data
- Source code can be accessed directly via the git repositories at git://git.phytec.de

Yocto and PHYTEC

Yocto Support in PHYTEC Linux Board Support Packages (BSPs)

BSP Software Components:

- Download of a BSP release is enabled through a support script called phyLinux
- Running the script will download the source code of the all software components, resulting in a full installation to a host-PC of Yocto with all required meta data needed to run a build

Yocto and PHYTEC

Yocto Support in PHYTEC Linux Board Support Packages (BSPs)

PHYTEC Linux Script

- Create a new project folder, such as

```
mkdir ~/yocto
```

- Download and run the init script:

```
cd ~/yocto
wget ftp://ftp.phytec.de/pub/Software/Linux/Yocto/Tools/phyLinux
chmod +x phyLinux
./phyLinux init
```

The script will prompt installation of the Repo tool in the /usr/local/bin path

- Alternately, the tool can be manually installed at a different location
- phyLinux will automatically detect Repo if it is found in the path
- The Repo tool is used to manage the different Yocto BSP git repositorie

Yocto and PHYTEC

Yocto Support in PHYTEC Linux Board Support Packages (BSPs)

Unified Yocto Board Support Package Platform Support Example: AM335x-PD-15.1.0

Machine Name	Hardware Part #:	Compile Test Passed	Series Test Passed
phyboard-maia-am335x-1	PB-00702-002	X	X
phyboard-wega-am335x-1	PB-00802-0200C (PEB-AV-01)	X	X
phyboard-wega-am335x-1	PB-00802-0101C (PEB-AV-01)	X	X
phyboard-wega-am335x-2	PB-00802-008 (PEB-AV-02)	X	X
phyboard-wega-am335x-2	PB-00802-010 (PEB-AV-02)	X	X
phycore-am335x-1	PCM-051-12102F0C.A1 (PCM-953, KPCM-051-x Linux Kit)	X	X
phycore-am335x-2	PCM-051-22151F0C(PCM-953)	X	not tested
phyflex-am335x-1	PFL-A-03-12113F8I.A1 (PBA-B-01)	X	X

Yocto and PHYTEC

Yocto Support in PHYTEC Linux Board Support Packages (BSPs)

		phyCORE-AM335x RDK	phyFLEX-AM335x RDK	phyBOARD-WEGA	phyBOARD-MAIA
Environment	Kernel	3.12.30			
	Yocto	1.7			
	OpenGL	OpenGL ES 2.0 (PowerVR SGX chipset driver 5.01.01.02)			
	QT	5.3.2			
Interfaces					
SPI					
	NOR Flash	YES	YES	-	YES
I2C					
	EEPROM	YES	YES	YES	YES
	PMIC	YES	YES	YES	YES
	Touch	YES (capacitive)	YES (capacitive)	YES (capacitive)	YES (capacitive)
	RTC	YES	YES	YES	YES
	ADC	-	YES	-	-
CAN		YES	YES	YES	YES
Ethernet		(ETH1/ETH2)	(ETH1/ETH2))	(ETH1/ETH2))	(ETH1/ETH2))
UART		YES	YES	YES	YES

About PHYTEC

28 years of profitability; no external capital or debt

Founded in Mainz, Germany: 1986

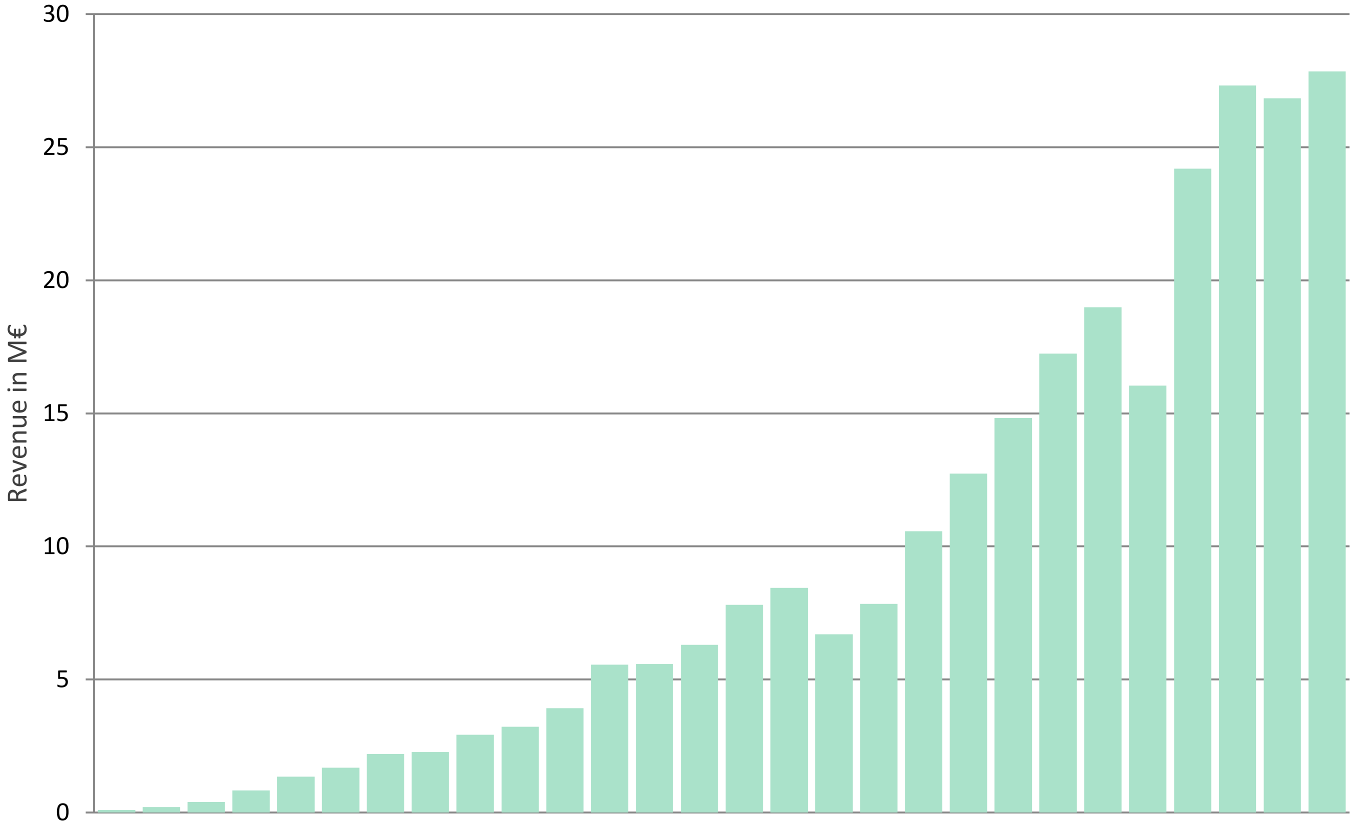
- First European company with OEM-able module

2014 revenues: $38.5 million

- 28 years of profitability
- No external capital

Global employees: 201

- PHYTEC France: 1994
- PHYTEC America: 1996
- PHYTEC India: 2012
- PHYTEC China: 2014



PHYTEC End-to-End Solutions

Single Source for the Entire Product Lifecycle

COTS	Design	Manufacturing	Logistics	Lifecycle
SOMs	System Design	Prototyping	Direct	BOM Management
SBCs	PCB Design	In-House SMT	Demand Pull	QA/Warranty
Kits	Kernel and Drivers	Box Build	Consignment	Support
Accessories	Mechanical	Test	Open Book	Product Ramp

Deployed Across Many Industries

PHYTEC

TEST AND MEASUREMENT

PRECISION AGRIGULTURE

ENERGY

AUTOMATION AND CONTROL

MEDICAL/HEATHCARE

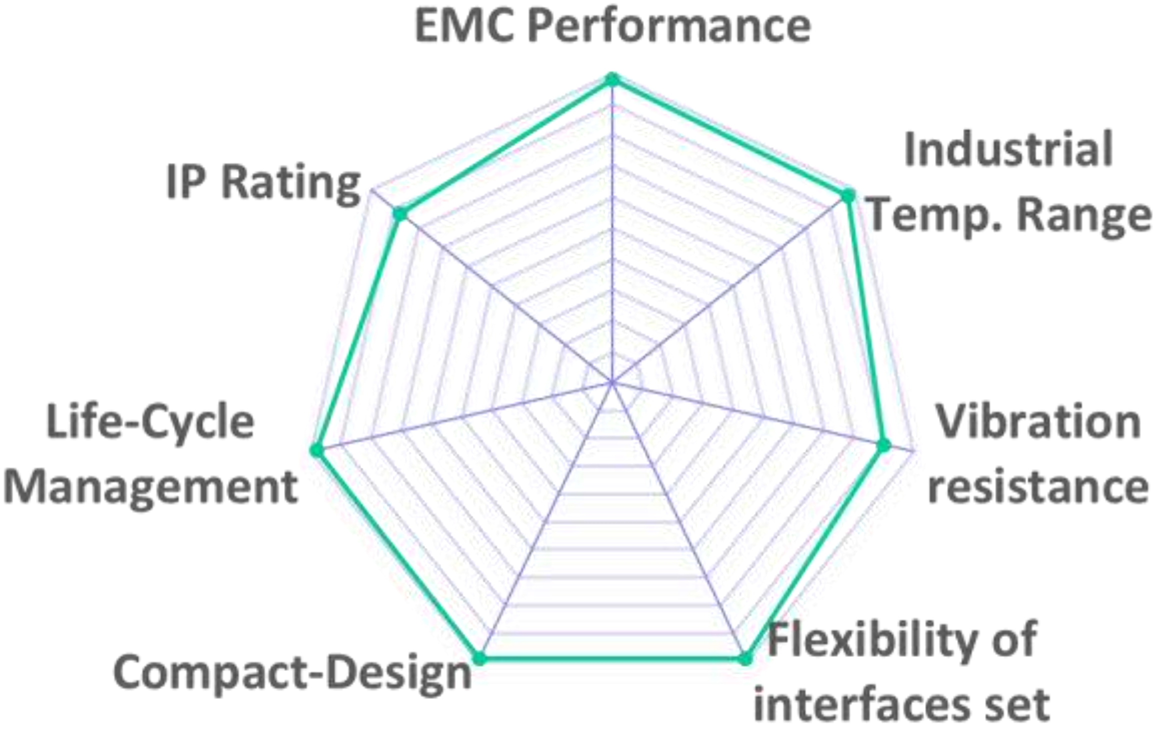
FITNESS

SECURITY

BUILDING AUTOMATION

TRANSPORTATION

Industrial Embedded Board products Feature



PHYTEC System on Modules

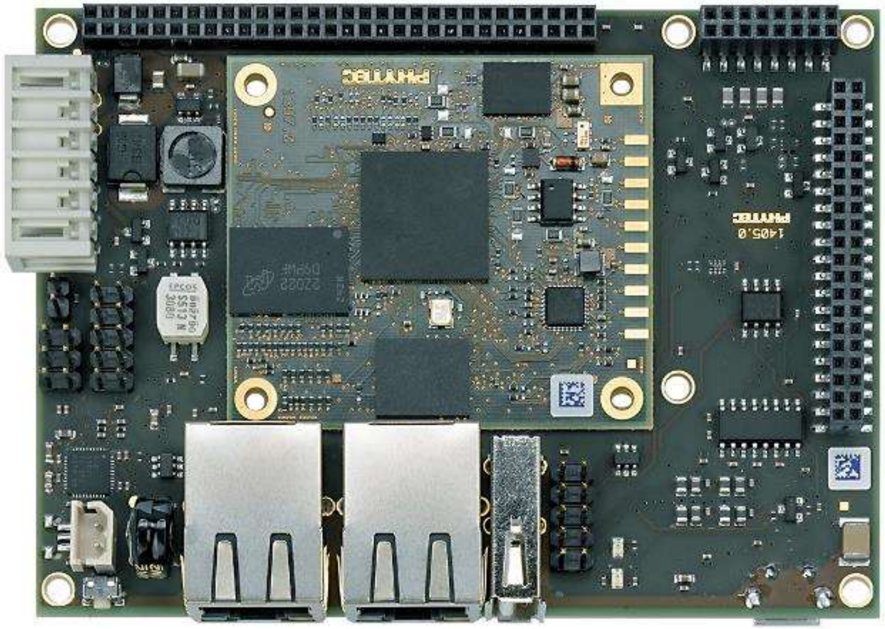
Cutting-edge processor and peripheral support

- ARM® Cortex™ M4, -A5, -A8, -A9, -A15, -A7
  - Single, Dual and Quad cores
- Advanced interfaces: DDR3, NAND, SATA, PCIe, USB3, gigabit Ethernet, LVDS, CAN, SPI, I2C, SD/MMC/SDIO
- Industrial-grade
  - Thermal management and POH analysis
  - Ultra-compact, multi-layer PCB
  - EMI-resistant design
- Linux, Android, Windows Embedded, RTOS
- FCC/CE compliant

PHYTEC Single Board Computers

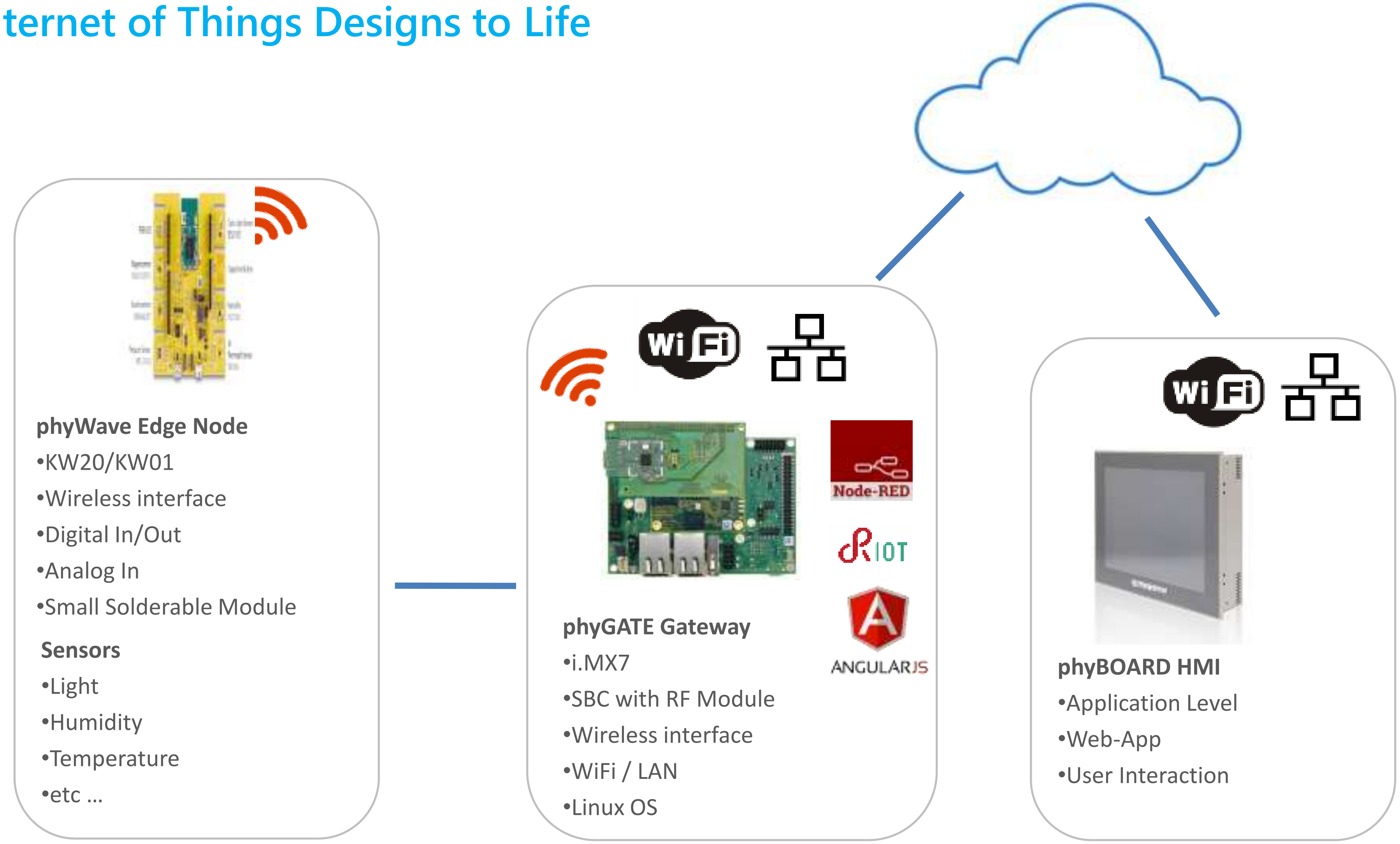
Industrial Building Blocks for Product Development

- ARM® Cortex™ -A5, -A8, -A9 SOM populates Carrier Board that provides I/O connectivity
- SOM mounts on Carrier Board via “Direct Solder Connect” (DSC) or connectors
- SOM on I/O Carrier Board = deployable Single Board Computer (SBC)
- Easy modification of the I/O Carrier Board due to layout stacks = customization according to needs of end application and cost targets
- Optional:
  - HMI (LCD / Touch)
  - Housing
  - Expansion Modules connect to Carrier Board Expansion Bus: HDMI, Power Supply, Industrial I/O, M2M



PHYTEC IoT Enablement Kit

Bringing Internet of Things Designs to Life



phyWave Edge Node

- KW20/KW01
- Wireless interface
- Digital In/Out
- Analog In
- Small Solderable Module

Sensors

- Light
- Humidity
- Temperature
- etc …

phyGATE Gateway

- i.MX7
- SBC with RF Module
- Wireless interface
- WiFi / LAN
- Linux OS

phyBOARD HMI

- Application Level
- Web-App
- User Interaction

High-Quality Manufacturing

PHYTEC

Bringing Designs to Life

- 4x in-house SMT assembly lines
  - Samsung SM411, SM421
  - Advanced SMD: 0.4 mm pitch BGA, PoP, DSC
  - 100% AOI and Traceability
- ISO9001:2008 Certification
- Conformance
  - RoHS, REACH, WEEE
  - IPC-600A-F class 2, 3 PCBs
  - IPC-610A-D class 2, 3 assembly
  - J-STD-004, UL, VDA, KTA1401 and other on request
- HMLV to Volume Production
  - scalable from in-house lines to production partners in Texas and China
  - Life-Cycle Management, Supply Chain Logistics

Why PHYTEC?

PHYTEC

Production Development Solutions: from Building Blocks to Turn-Key

28+ Years Expertise in Embedded Domain

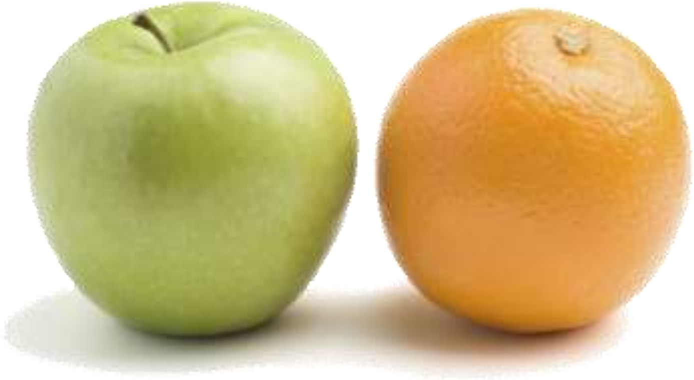
- Ruggedized Industrial Embedded Hardware: SOMs and SBCs
- Easy Modification and Customization
- Operating System Support
- Designed in Germany and USA

Services

- SOM and SBC Design-In
- System Integration and Turn-Key Development

Scalable Manufacturing

- “Made in Germany”
- International Production Partners: USA and China



Value Proposition

- “Outsource” embedded hardware and operating system software to PHYTEC
- 100 – 50K unit/year solution = Reduce time, development cost and design risk