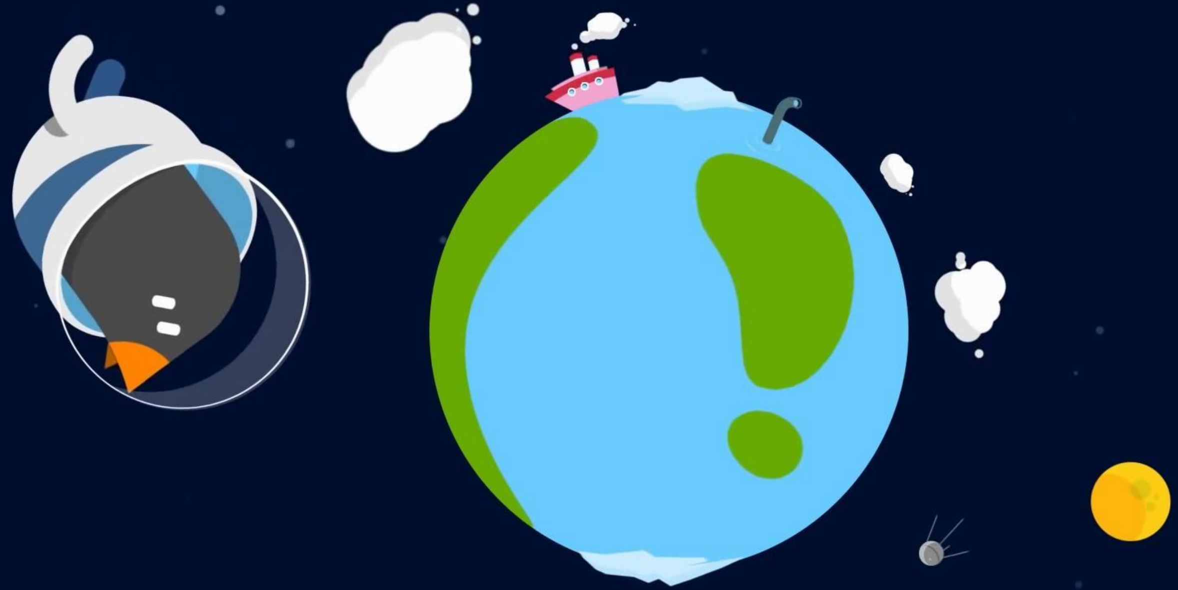
ROS on OpenEmbedded

Simpler Robotics Development



LG Electronics, USA

ROSCon 2019 - Macau

Agenda

- Introduction and Motivation: Mass-market Robots
- Development with ROS + OpenEmbedded
- webOS Robotics
- Demo

webOS
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Introduction and Motivation: Mass-market Robots

Brian Shin

Robots for Mass Market: Expectations

- Full Experience on small form factor
- Multiple Variants & Reproducibility
- Optimized for Low Cost
- Advanced User Experiences
- Up-to-date with software and security

Possible path: reduce hardware cost + simplify software development and maintenance

Embedded Product: Introduction

- **Embedded Hardware** (Single Board Computers)
- Customized for dedicated function
- Low memory footprint
- Low power consumption
- Real-time performance

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Embedded Software: Challenges

- Multiple Hardware variants
- Cross Development
- Significant Customizations
- Lot of Optimizations

https://elinux.org/images/0/0a/Embedded_Linux_Build_Systems.pdf

Robots for Mass Market: Possible Solution

- Embedded hardware (low cost)
- OpenEmbedded (simple base Embedded Linux)
- ROS on OpenEmbedded (meta-ros)
- webOS (rich product features on OpenEmbedded)

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Development with ROS + OpenEmbedded

Herb Kuta

OpenEmbedded (OE): Introduction

- Build system for the Linux Foundation's Yocto Project
- Cross-compilation for many CPU architectures
- Wide variety of chipset and board support
- Provides a customizable "OpenEmbedded Linux"
- Input: recipes and configurations ("metadata")
- Output: package archive **plus** bootable images
- Completely reproducible builds
- Organized into independent layers => expandable

YOCTO

"create custom Linux-based systems regardless of the hardware architecture"

Recipe (.bb)

```
DEPENDS        # Build-time dependencies
RDEPENDS       # Run-time dependencies
SRC_URI        # Location of source

do_fetch()     # Fetch the upstream source
do_patch()     # Patch it with your changes
do_configure() # Run CMake, autoconf, etc.
do_compile()   # Compile
do_install()   # Select what's installed
do_package()   # Package what's installed
```

https://www.openembedded.org/ https://www.yoctoproject.org/

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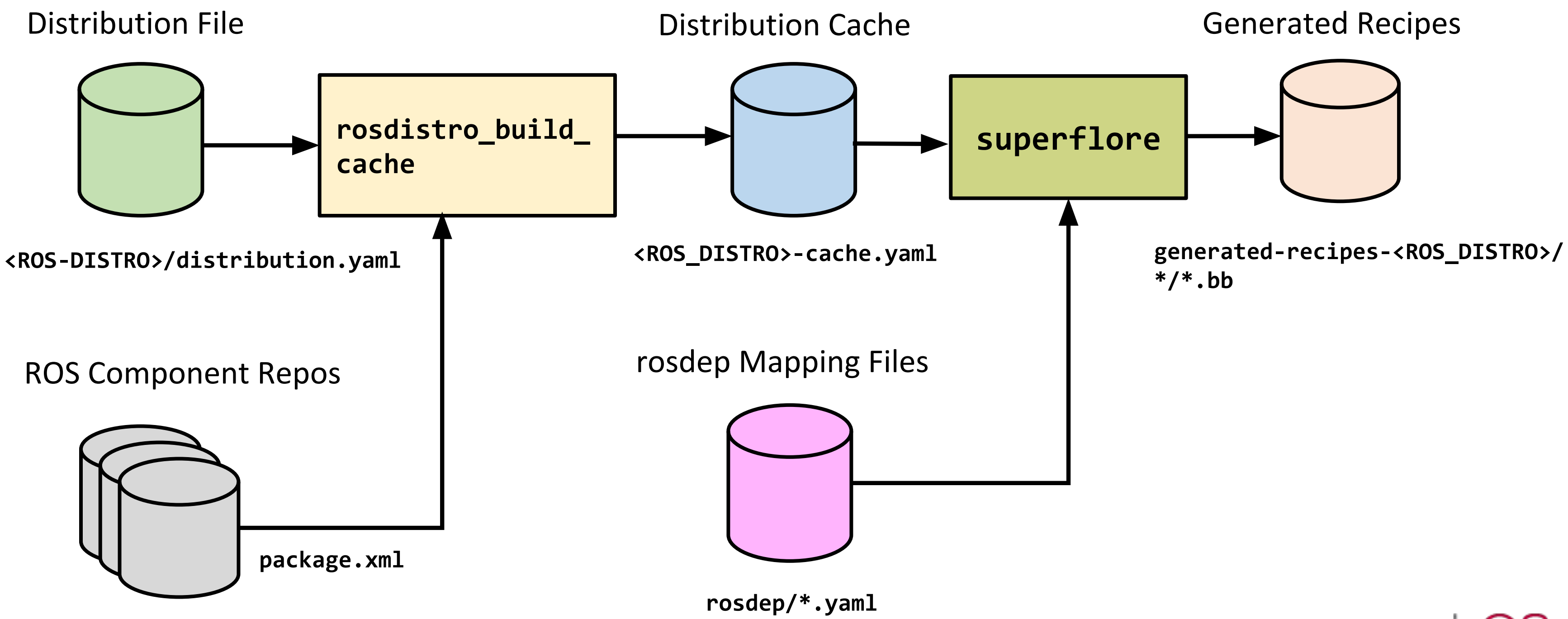
meta-ros v2: OpenEmbedded Layers for ROS 1 & ROS 2

Super Flore: An extended platform release manager for ROS



https://github.com/ros-infrastructure/superflore

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meta-ros: How to use for development

Build ROS Image

```
# Clone meta-ros
$ git clone git@github.com:ros/meta-ros
# Setup OE layers
$ meta-ros/scripts/mcf -f conf/ros2-dashing.mcf
# Setup build environment
$ source openembedded-core/oe-init-build-env
# Configure the build
$ vi conf/local.conf
# Build an image
$ MACHINE=raspberrypi4 bitbake <image>
```

Add/Modify ROS Package

```
# Clone your ROS package source
$ git clone git@github.com:<ros-package>
# Generate (or regenerate) recipe
$ ros-generate-recipes <ros-package>
# Add your package to the image
$ vi conf/local.conf
# Build an image with your package
$ MACHINE=raspberrypi4 bitbake <image>
```

https://github.com/ros/meta-ros

[OpenEmbedded Build Instructions]()

Case Study: Simplified Deployment (TurtleBot3 Waffle Pi)

Current Scheme (with remote PC)

1. Install Ubuntu, ROS and TB3 application packages on the **remote PC**
2. **Install unspecialized Ubuntu and ROS for generic Arm architecture on RPi**
3. **Download source code for TB3 packages and build them on RPi**
4. **SSH into TB3 and setup device instance configuration (hostname, WiFi SSID, etc.)**
5. **Configure remote PC and RPi to communicate with each other**
6. **Launch `roscore` and TB3 ROS applications on remote PC**
7. **Launch TB3 ROS nodes on RPi. TB3 is operational**

→

OpenEmbedded Based (no remote PC)

1. **Build image with specialized OpenEmbedded and ROS optimized for RPi on a build PC**
2. **Load device instance configuration (hostname, WiFi SSID, etc.) and TB3 ROS nodes to start upon boot on USB flash drive**
3. **Flash image on SD card, insert it and USB flash drive into RPi, and boot. TB3 is operational**

http://emanual.robotis.com/docs/en/platform/turtlebot3/setup/#setup

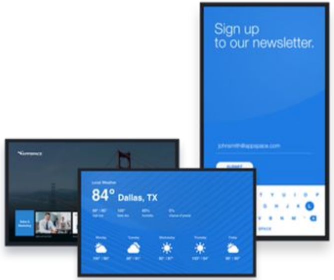
webOS Robotics

Lokesh Kumar Goel

LG webOS: Path to complete product

webOS is adopted on many LG devices.

Smart TV



Digital Signage

Smart Watch

Smart Refrigerator

Robot

Open Source Edition

ROS Qt openembedded YOCTO

webOS

https://www.webosose.org/

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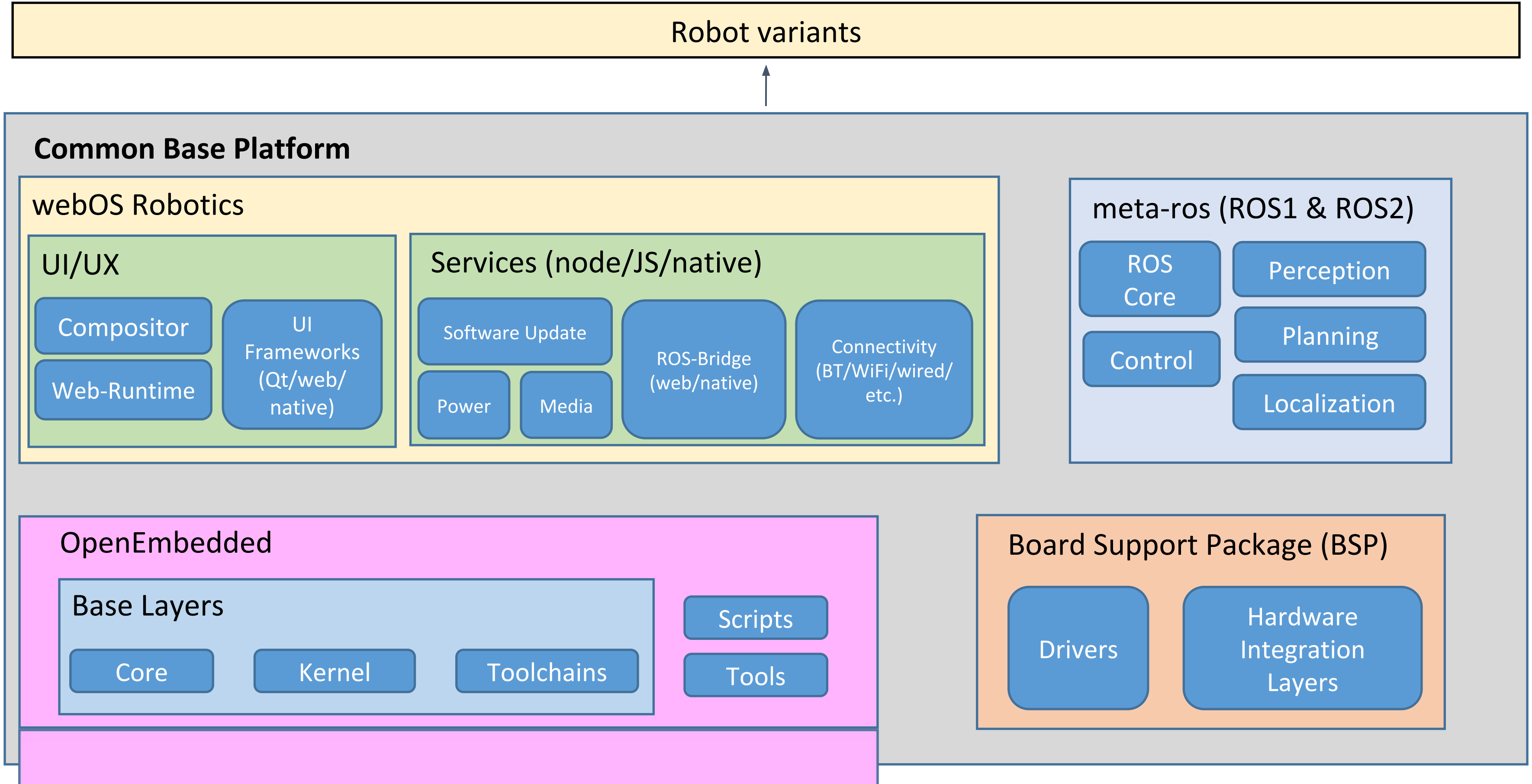
OpenEmbedded + ROS + webOS: Advantages

- Optimized for embedded hardware (power, CPU, memory)
- Capabilities for advanced user experiences (apps/services)
- Rapid web-based application development
- Software update pipeline (from cloud to device)
- White-labeled OS (rebrandable & redistributable)

webOS Robotics: Common Base Platform



webOS Robotics: Roadmap

Variants
- Service Robot (Service)
- Airport Robot (Concierge)
- Child Robot (Companion)

webOS: Specific
- Mobile App
- Airport App
- CMS
- Play App (Youtube Kids, Story Telling, Game)

ROS: Specific
- Pattern Navigation (different modes)
- Follow-me
- Emotion Engine (Face/Emotion detection)

ROS: Common
- SLAM
- Navigation
- Obstacle Detection
- Person Detection
- Joystick
- Parking Mode (return to charge station)
- Simulator (ROS + webOS)

webOS: Common
- Voice Assistant (Google AI)
- Build Profiles (with/ without UX)
- Flow Program-ming
- Software Update (OTA)
- Remote Control
- Offline Mode
- Cloud (OTA, Recovery, Diagnostics, Control)
- Multi-display

Reference Hardwares
- ROBOTIS TurtleBot3
- NVIDIA TX(n)
- Qualcomm RB3

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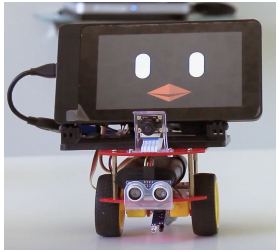
Demo

Lokesh Kumar Goel

webOS Robot Platform: Demo

- **ROSCON 2018: BeanBird Bot**
  https://youtu.be/lCGa7LkDNp0

- **ROSCON 2019: Big Bean Bot**
  https://youtu.be/nZ3QQ2HL5Vg



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ABOUT webOS

QUESTIONS

ABOUT OpenEmbedded

ANSWERS

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LG Life's Good

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