System Modes – Model-based Run-time State Management of Large Systems

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System Modes

Deliberation in robotics is complex

Three interwoven aspects:

1. Intended tasks
2. Contingencies
3. System-level errors
System Modes

Abstractions improve maintenance and extensibility

Missing abstractions for:

- States and lifecycle
- Parameters
- Diagnostics

Deliberation (BTs, SMACC2, PlanSys2, …)

Naming

pub/sub, actions, services

/nav_plan /diff_drive /camera /left/arm /right/arm
System Modes

Abstractions improve maintenance and extensibility

Missing abstractions for:
- States and lifecycle
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System Modes
Abstractions improve maintenance and extensibility

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Concepts

1. Modes for lifecycle nodes
   - Parameter value sets
System Modes

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1. Modes for lifecycle nodes
   ▶ Preconfigured parameter value sets

2. Hierarchy
   ▶ Recursive grouping of nodes into (sub-)systems
   ▶ Same lifecycle as nodes
System Modes

Concepts

1. Modes for lifecycle nodes
   - Preconfigured parameter value sets

2. Hierarchy
   - Recursive grouping of nodes into (sub-)systems
   - Same lifecycle as nodes

3. Modes of (sub-)systems
   - Mapping to states + modes of their parts
   - Inference upwards along the hierarchy
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Implementation

» Virtual layer implemented by System Modes **Manager Node**

» **No changes** to lifecycle node class!

» System hierarchy, states, modes, parameter values are specified in YAML

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**SHM File**

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**Deliberation (BTs, SMACC2, PlanSys2, ...)**

**Requested mode**

**Inferred mode**

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**/navigation**

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**/nav_plan**

**/diff_drive**

**/camera**

**/left/arm**

**/right/arm**

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> ros2 launch system_modes mode_manager.launch.py modelfile:=-~/my_shm.yaml
```bash
> ros2 launch system_modes mode_manager.launch.py modelfile:=~my_shm.yaml

> ros2 launch system_modes mode_monitor.launch.py modelfile:=~my_shm.yaml
```
System Modes

Example

<table>
<thead>
<tr>
<th>Mode</th>
<th>Default</th>
<th>Moderate</th>
<th>Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>/nav_plan</td>
<td>inactive</td>
<td>active.Slow</td>
<td>active.Fast</td>
</tr>
<tr>
<td>/diff_drive</td>
<td>active</td>
<td>active.Slow</td>
<td>active.Fast</td>
</tr>
<tr>
<td>part</td>
<td>target</td>
<td>state</td>
<td>actual</td>
</tr>
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<tr>
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<tr>
<td>diff_drive</td>
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<td></td>
</tr>
<tr>
<td>nav_plan</td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>
System Modes

- github.com/micro-ROS/system_modes
- Releases: Foxy, Galactic, Humble
- Work-in-progress – Feedback welcome!

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Advanced use-case with Metacontrol

https://youtu.be/j67xXNIdRkQ