

REAL-TIME OFFSHORE CRANE TELEOPERATIONS POWERED BY GSTREAMER

PALFINGER

GStreamer Annual Conference
Prague, October 10th-11th 2026

Adam Blonsky – Palfinger



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LIFTING SOLUTIONS FOR EVERY CHALLENGE

Palfinger | 11 October 2026 2



MARINE CRANES



OFFSHORE
CRANES



WIND CRANES



WINCHES, LIFTING-
AND HANDLING-
EQUIPMENT



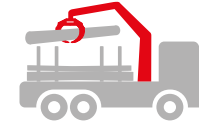
DAVITS



BOATS



LOADER
CRANES



TIMBER/RECYCLING



HOOKLIFTS &
SKIPLOADERS



TAIL LIFTS



PASSENGER SYSTEMS



ACCESS
PLATFORMS



TRUCK
MOUNTED
FORKLIFTS



RAILWAY
SYSTEMS



TURNKEY
SOLUTIONS

PALFINGER

PALFINGER MARINE



WHY REMOTE CRANES?



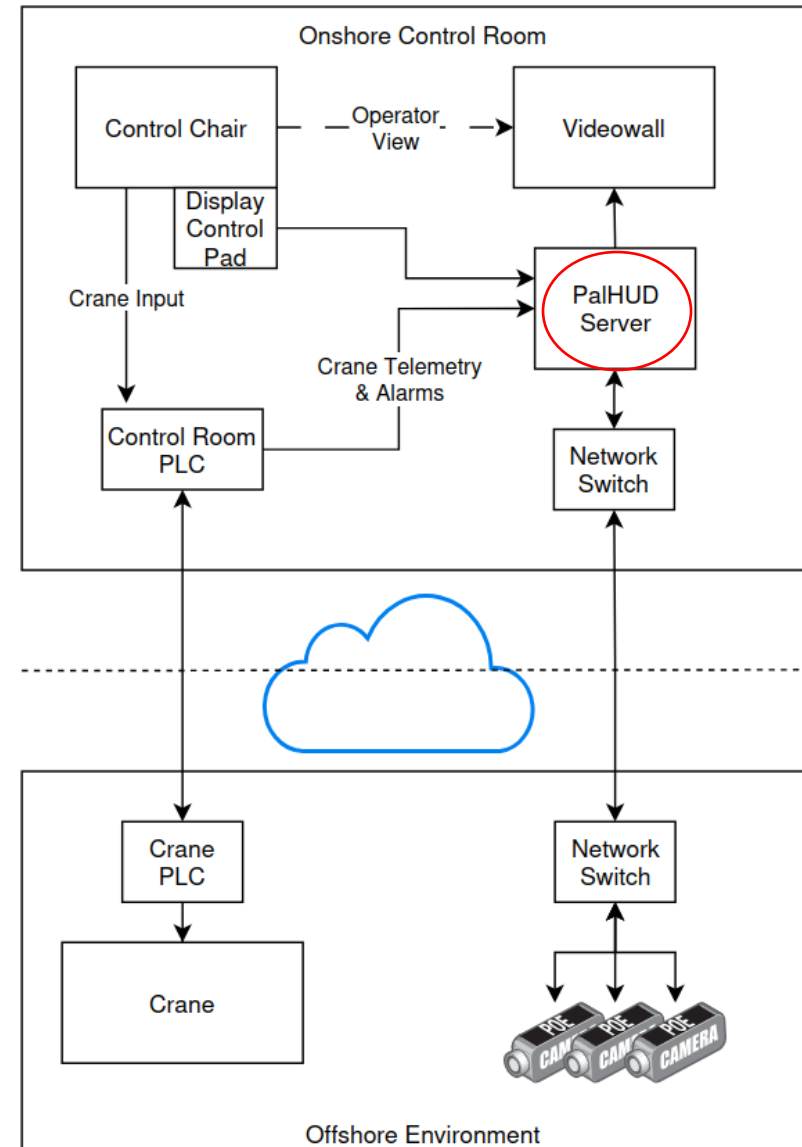
Valhall platform - AkerBP

SYSTEM REQUIREMENTS

- Real time
 - Operators must be able to drive the crane in real time as though they are actually offshore
 - Quickly changing situations (ships moving on waves) mean even small delays are unacceptable
- Flexible layouts
 - Different situations require different cameras and views so the system must support dynamic layout changes
 - Required layouts may change overtime so new layouts should be easy to add and change
- System telemetry
 - System has to display real time crane information (eg outreach/load) and alarms
- Reliable
 - Large energy regimes that are high risk (multiple tons hoisted high in the air)
 - Highly regulated environment (Norwegian continental shelf)

SO WHAT DID WE BUILD TO FULFILL THESE REQUIREMENTS?

- We built PalHUD (Palfinger Heads Up Display)
- Physical server with our software on it built on top of GStreamer Python hooks which is embedded in the control room
- Displays camera streams with overlays showing crane information
- Records health telemetry about the various streams and health of PalHUD itself



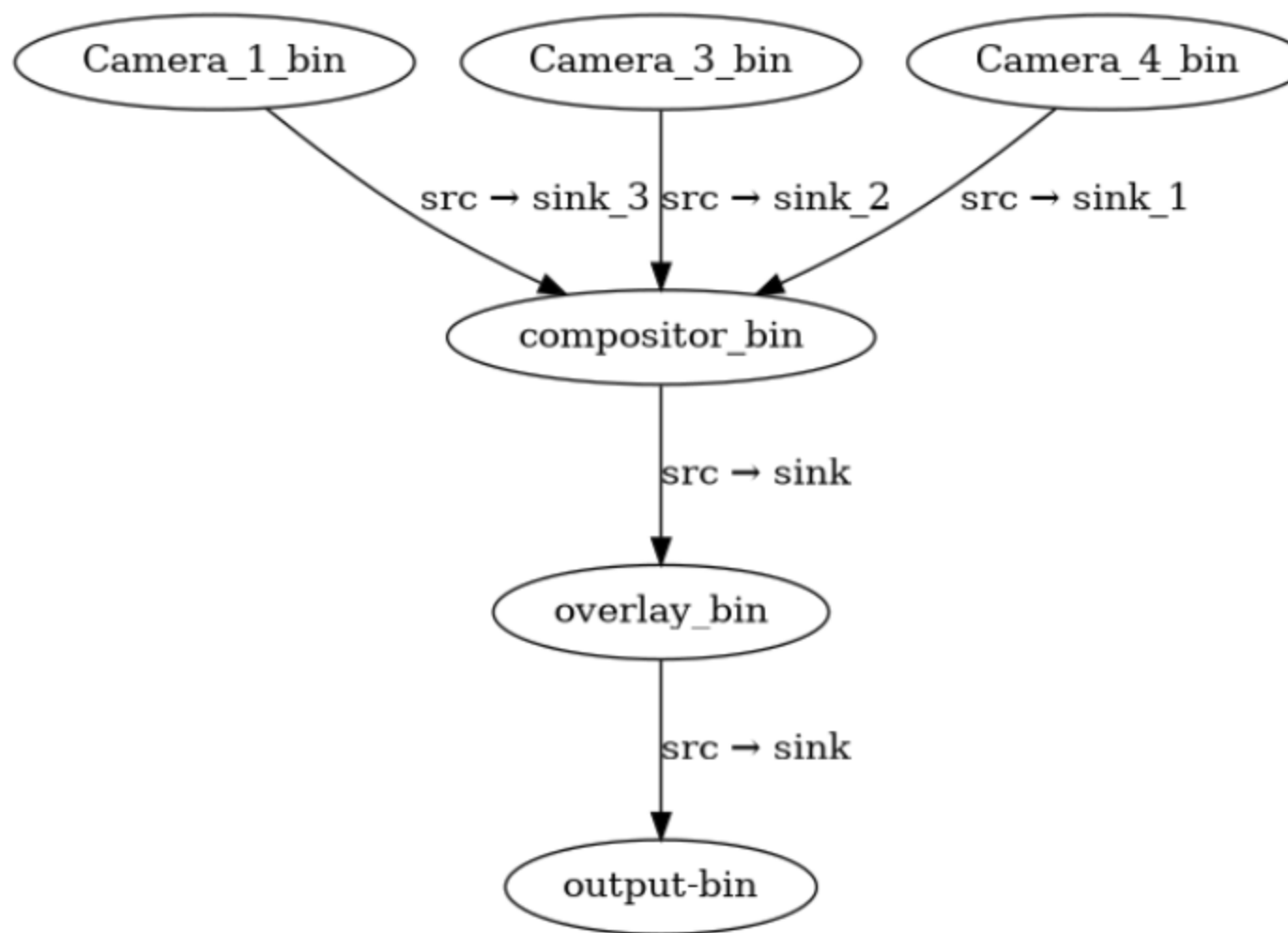
WHY GSTREAMER?

- Small team
 - We don't have time or resources to reinvent a bunch of multimedia primitives
- Flexibility
 - Other tools are too rigid for the system we want to build with custom layouts/overlays/telemetry
- Performance
 - GStreamer is optimized for performance, absolutely needed for real time operation
- Reliable
 - Tried and tested technology that has been used by many other teams over the years

PALFINGER REMOTE OPERATIONS CENTER (PALROC)

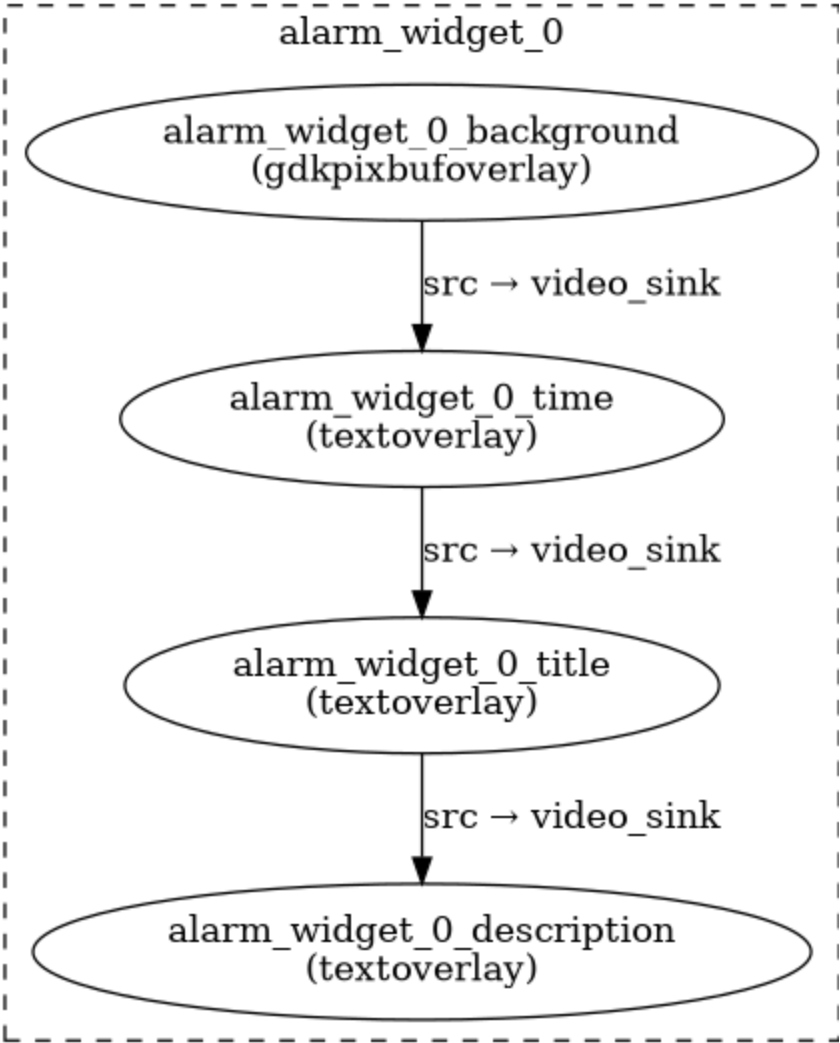
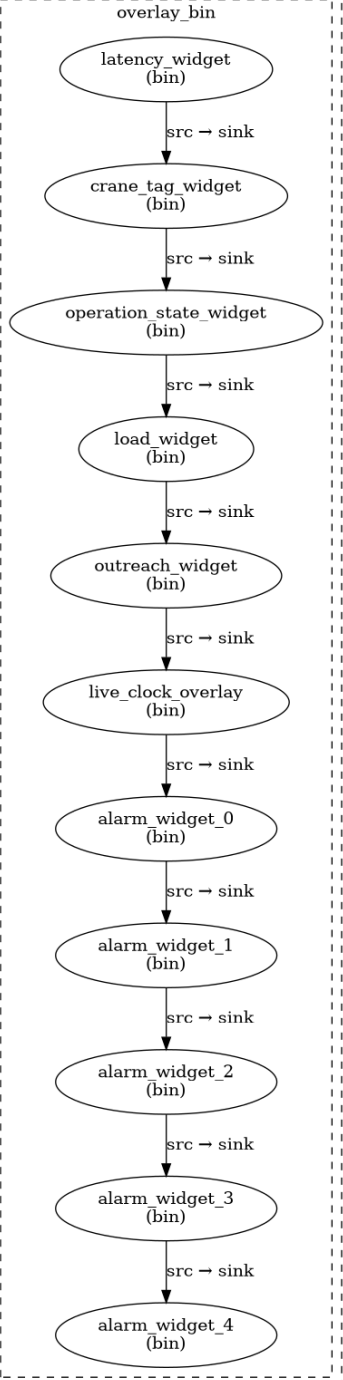


WHAT IS PALHUD - PIPELINE









LATENCY MEASUREMENT

Measurement method:

"Glass to glass"

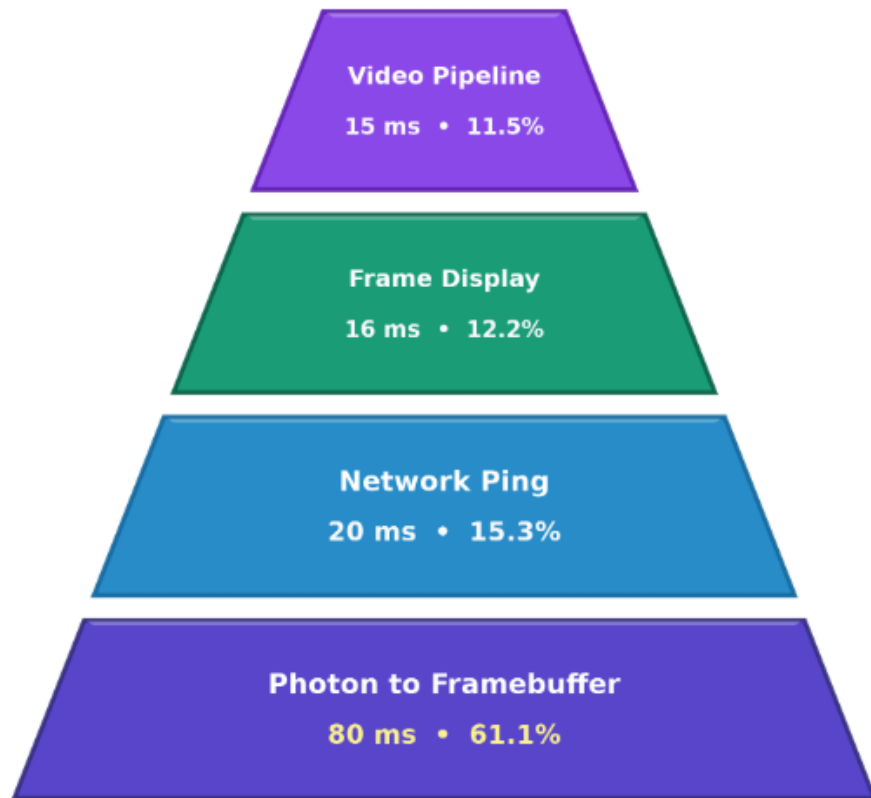
Set up a camera looking at a display with the time then display that clock with the current time

Both computers are synced to the same NTP server

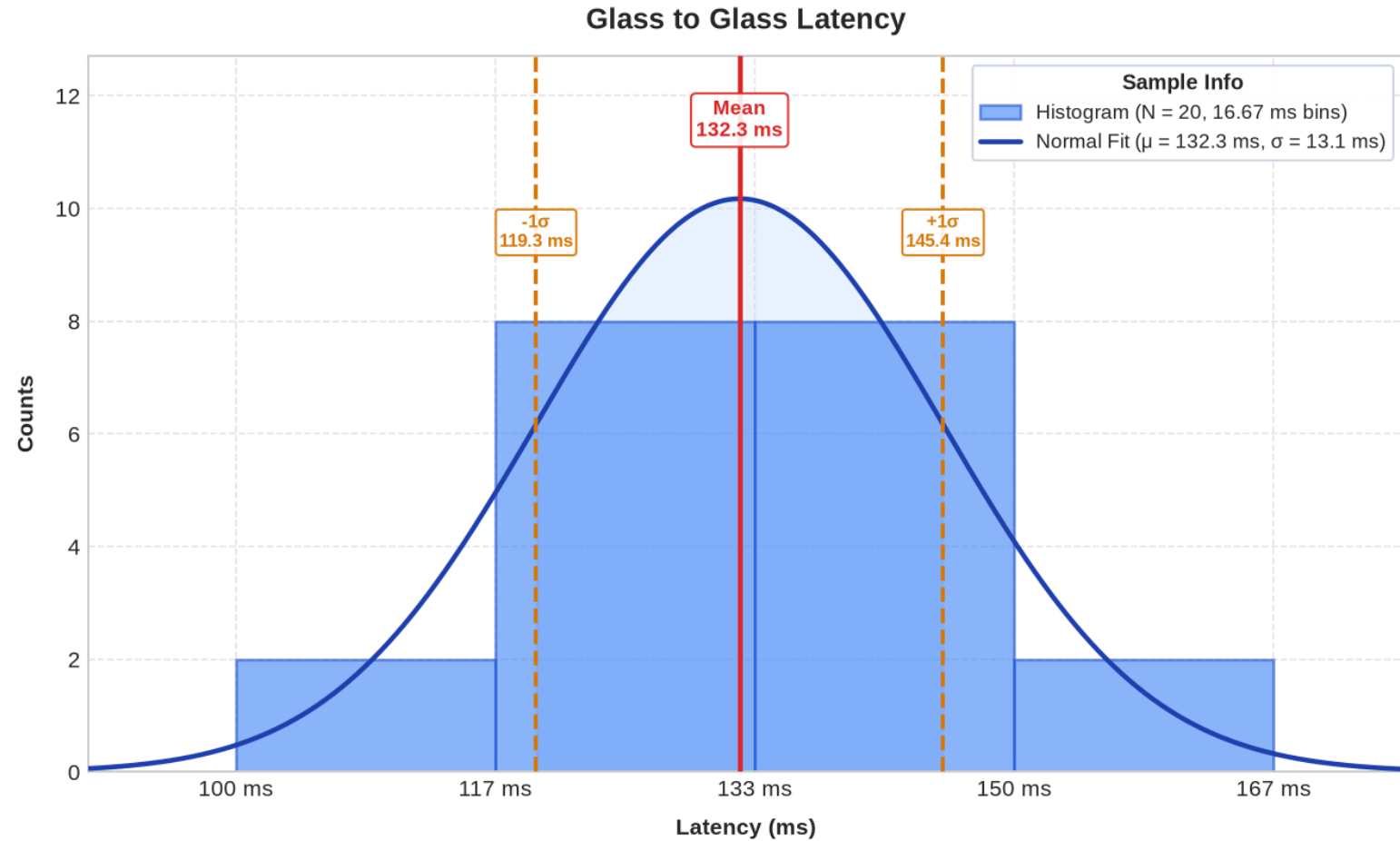


Glass to glass method: remote location display in Poland (left) and on-site display in Norway (right)

GLASS TO GLASS LATENCY MEASUREMENT



Average Latency Sources



LATENCY REQUIREMENTS

System requirement is "**real time**"

What is real time? 1ms? 10ms? 100ms? 1000ms?

Literature says ~170ms (Zhang et al) for remote operation of cars

"Some prior studies show that constant total latencies below approximately 170 ms have a mild influence on teleoperation performance [26], [27], [30], [34]. Studies also reveal that when the total latency stays below 300 ms, human teleoperators can usually adapt their driving behavior to compensate for the latency without significantly sacrificing control performance in many case"

But that is cars not cranes...

LATENCY EXPERIMENTS WITH OPERATORS

Operator	Delay (ms)								
Added Latency (ms)	0	100	200	300	350	400	500	600	1000
Total Latency (ms)	150	250	350	450	500	550	650	750	1150
Operator 1									
Operator 2									
Operator 3									
Operator 4									
Operator 5									

	Not Tested
	No delay felt
	Delay felt, but operable
	Too much delay, cannot operate

LAYOUT CONTROL

Operators need to switch between different layouts depending on need (eg Inspection before use, operation, maintenance)



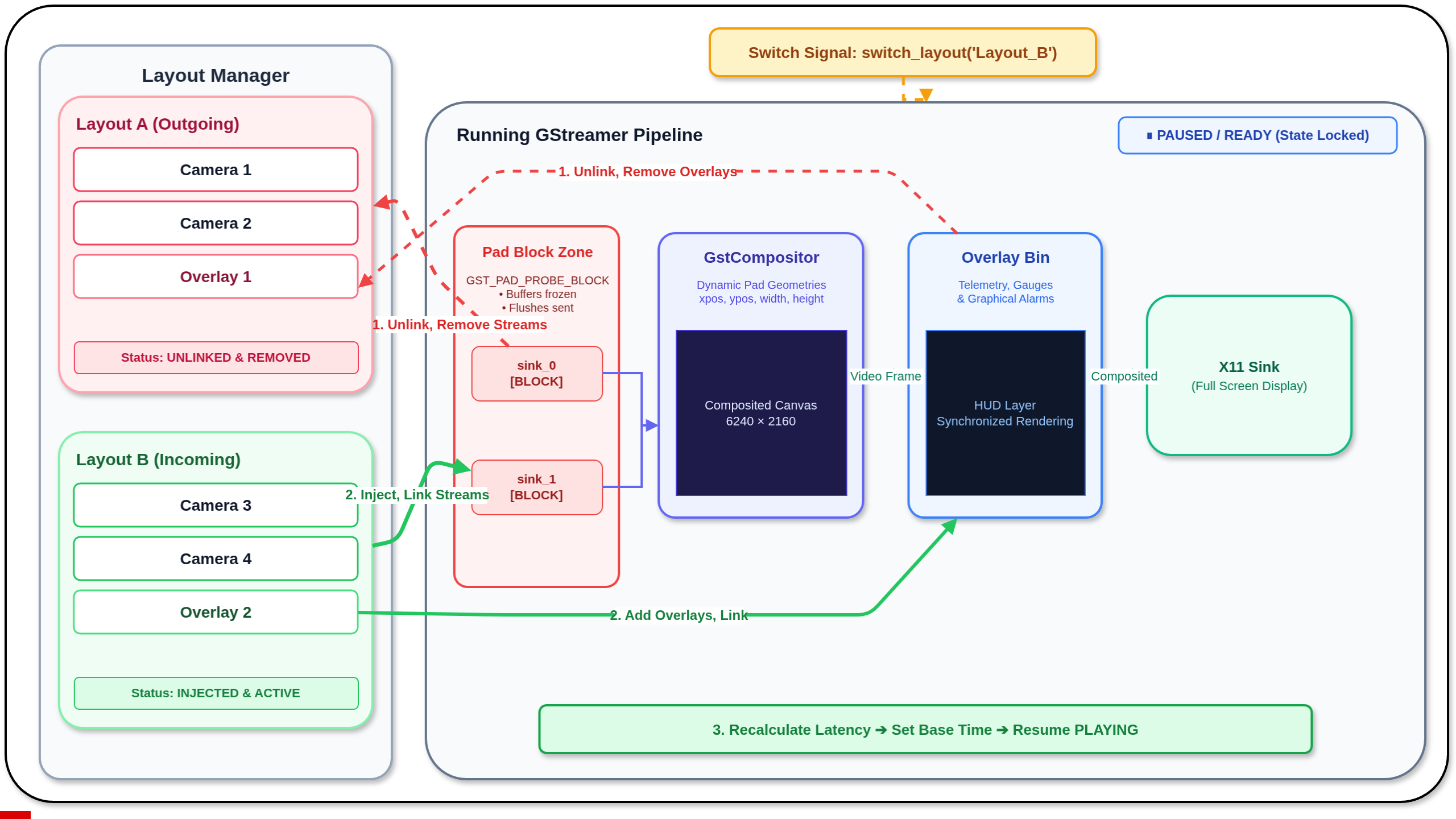
Example layout used to drive a test crane

LAYOUT CONTROL

- Layouts are defined by JSON
 - Human readable schema
 - Maps easily to underlying GStreamer system
 - Easy for UX designers to update based on their design files
 - No code required for adding and changing layouts
- Each layout has its own JSON and held in memory ready to swap
- Video streams placed via compositor

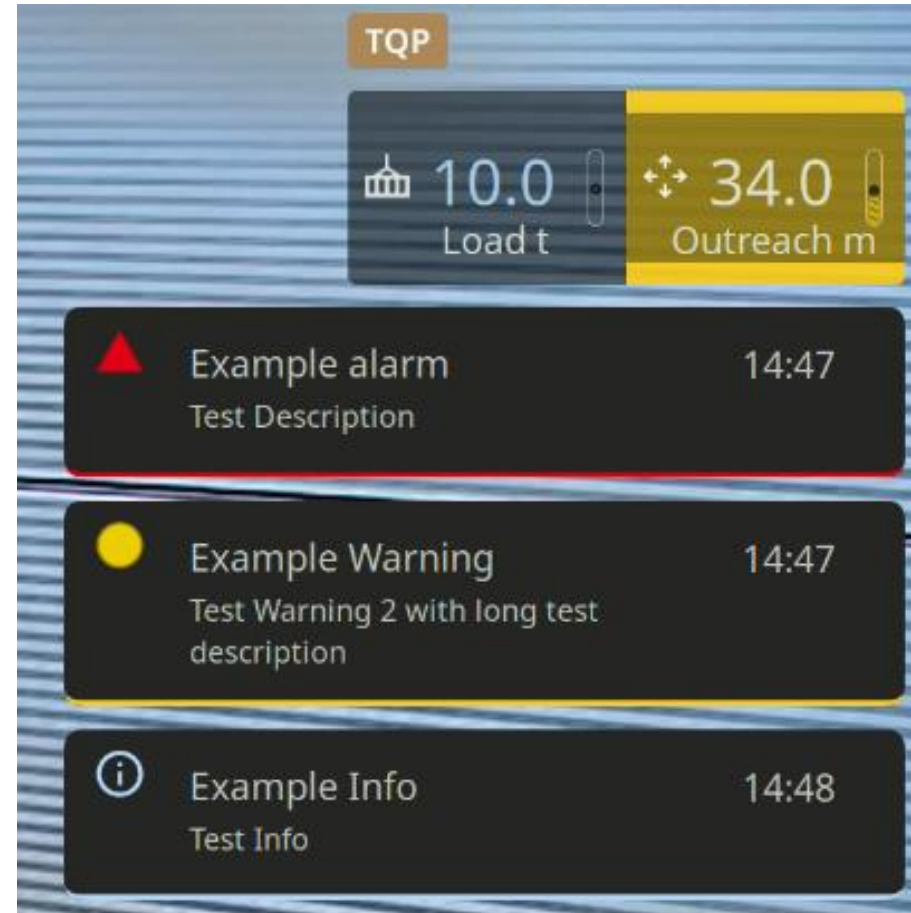
```
{
  "layout_name": "Example Layout",
  "layout_width": 6240,
  "layout_height": 2160,
  "video_sources": [
    {
      "name": "boom_tip_cam",
      "type": "rtsp",
      "video_source": "rtsp://camera-ip/stream1",
      "compositor": {
        "xpos": 0,
        "ypos": 0,
        "width": 3840,
        "height": 2160 }
    }
  ],
  "overlays": [
    {
      "name": "crane_gauge",
      "type": "widget",
      "config_type": "generic_opcua_widget",
      "config": {
        "offset_x": 100,
        "offset_y": 100
      }
    }
  ]
}
```

Example layout schema



SYSTEM TELEMETRY

- Crane Telemetry
 - OPCUA + Redis
 - Text overlays dynamically updating from redis
 - Alarm service for instant display of alarms to operators
- PalHUD Telemetry
 - Pipeline latency
 - Server resource usage (CPU/GPU/Memory)
 - Stream health (rtpjitterbuffer packet statistics)

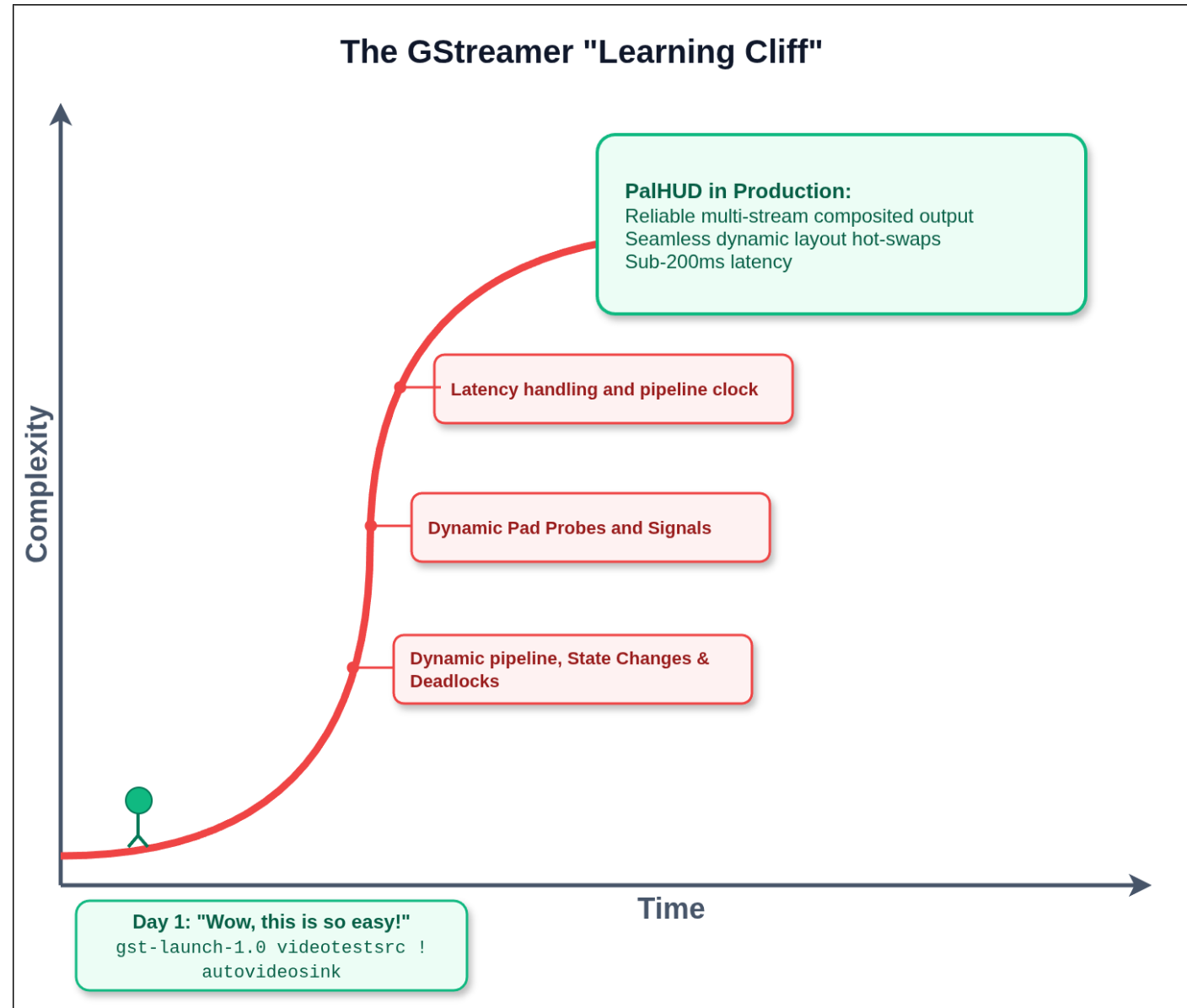


RELIABILITY

- Automated Video Failover
 - Layout defined fallback chains per stream (e.g. Boom Cam → Secondary Boom → Wide Deck).
 - In-pipeline pad blocking isolates failures without disrupting other feeds.
- Host-Level Redundancy (in progress)
 - Standby HUD machine listens to primary node health metrics via RPC/heartbeat
 - Immediate failover engagement if primary process or display stalls
- Decoupled Machine-Level Safety
 - Crane-side safety PLCs operate fully autonomous interlocks
 - Complete network or telemetry loss automatically triggers fail-safe crane park states

IMPLEMENTATION DIFFICULTIES

- GStreamer learning cliff
- Understanding dynamic pipelines
 - So many nitpicks and other small details that are difficult to understand and not well documented
 - So many pad probe types!
 - Pipeline state management
- GStreamer telemetry
 - Tracers don't carry through to Python easily
- Buffer flush subtleties



REMOTE OPERATION TOOLS FOR QUALIFICATION

TRL5-1 & MAJOR ACHIEVEMENTS



BERGEN
NORWAY

PALROC

VIDEO SYSTEM
UX & HF DESIGN
LATENCIES
DRIVING



GDYNIA
POLAND

HUGIN A **HUGIN B**



WHAT'S NEXT?

NEXT STEPS

Aker BP – Remote Offshore Cranes

Testing

from IOC to
Cranes at Yard

Testing

from IOC to
Cranes Offshore

Future use cases for Wind Parks?

Remote Testing of Cranes

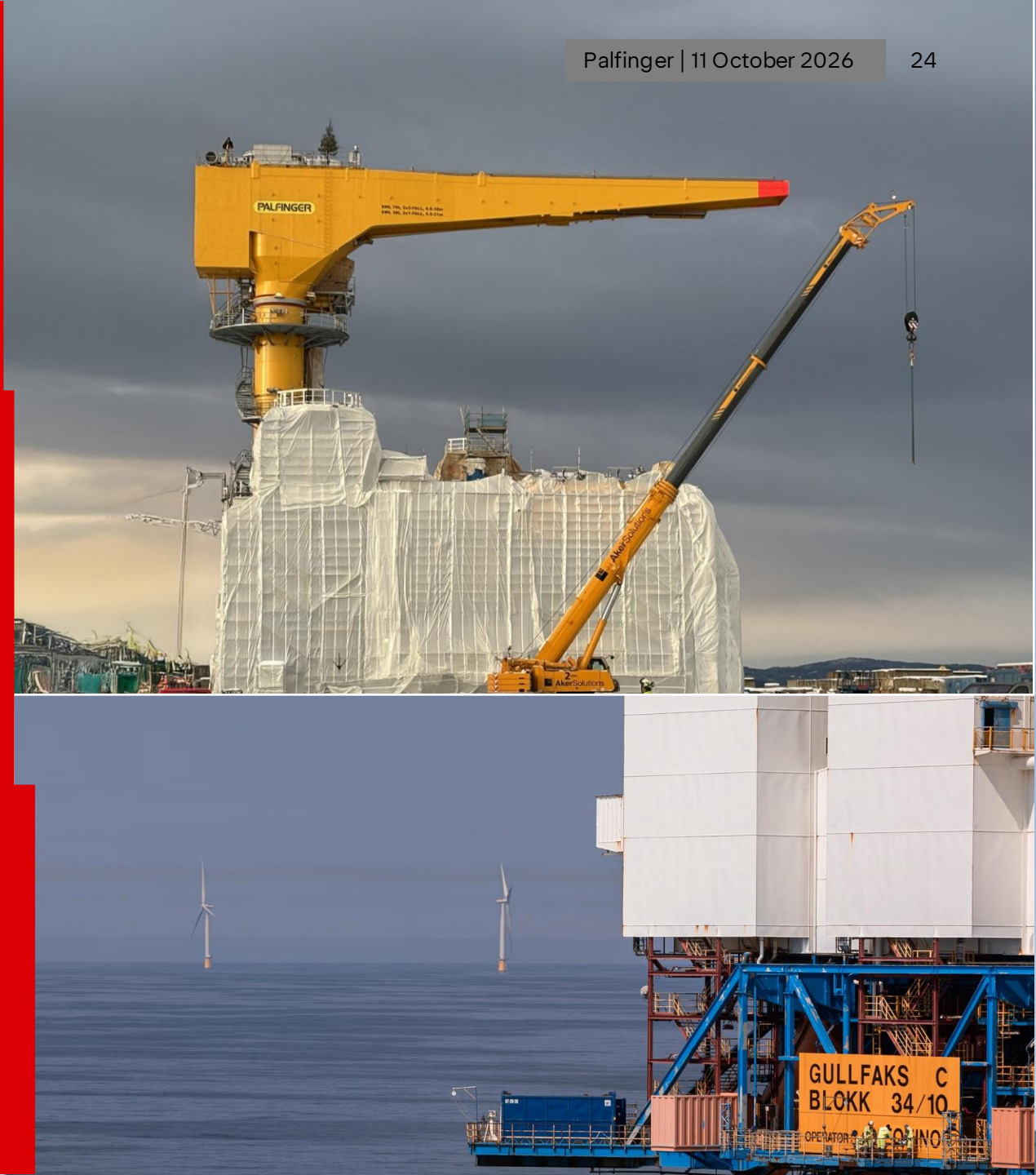
linked to onshore control room Baltyk
2&3 Equinor/Polenergia



Remote Crane Operation

from 2030?

ONGOING DISCUSSIONS



THANK YOU FOR YOUR ATTENTION!

