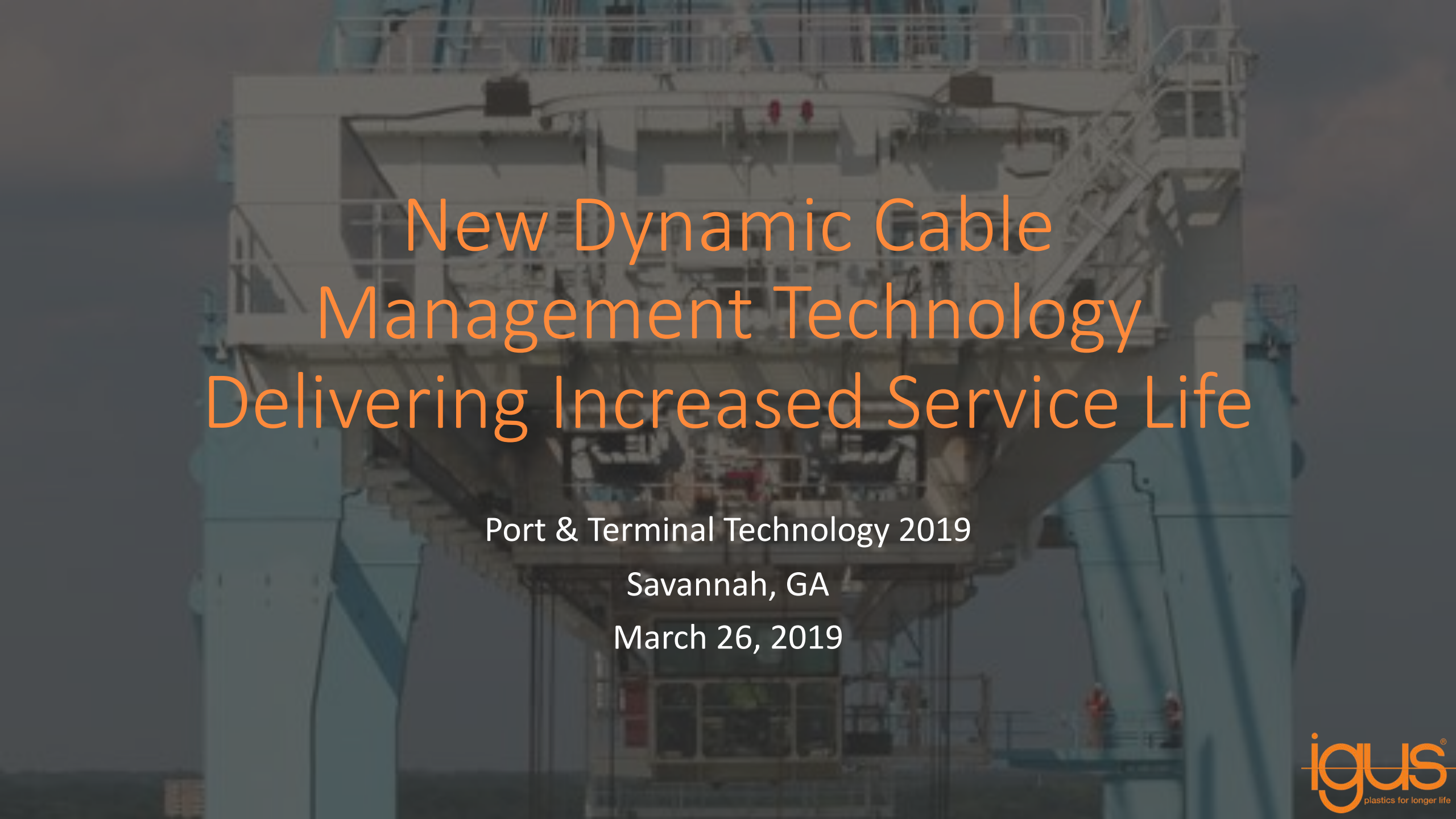

New Dynamic Cable Management Technology Delivering Increased Service Life

Port & Terminal Technology 2019

Savannah, GA

March 26, 2019

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Industry Challenges Affecting Trolley Travel Cable Management

- **Faster** trolley speeds
- **Longer** crane outreach
- Pressure to **increase throughput**
- **Reduce maintenance**
  - Downtime
  - Cost of wear parts and labor

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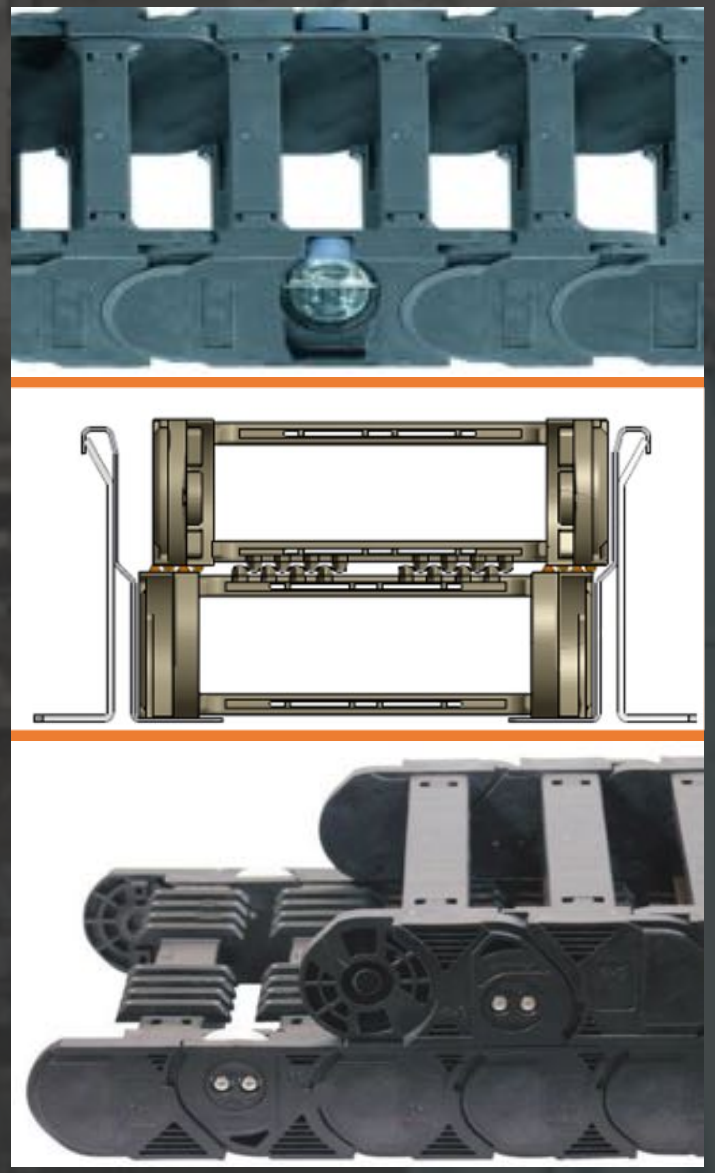
Current Technology – Capabilities & Overview

- **Rol E-Chain**
  - Integrated wheel for gliding
  - Installed on port applications beginning 1999
- **Heavy Duty Rol E-Chain**
  - Integrated wheel with wider side link/glide surface, larger stops
- **P4**
  - Offset integrated wheels, “auto-glide” crossbars



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New Technology – Capabilities & Overview

- **P4.1i**
  - Integration of plain bearings into the pin/bore connection of each chain link
  - Optional smart technology for predictive maintenance
- Backwards compatible – works with previous generation design
- Already in the field

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New Technology – Capabilities & Overview

- **P4.1i**
  - Capable of 10m/s travel speed
  - Extreme long travel – up to 800m
  - ***Service life of 20 years or 30,000 trolley hours!***

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Supporting Components Ensuring System Longevity

- **Floating Tow Arm**
  - Compensates for lateral deviation experienced at the moving end of the system
  - Helps eliminate excessive wear/damage on the trough and chain from occurring

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Supporting Components Ensuring System Longevity

- **Push-Pull Detection System**
  - Uses a load cell mounted at the moving end of the system to detect abnormal force events
  - E-stops trolley to allow maintenance personnel to perform inspection

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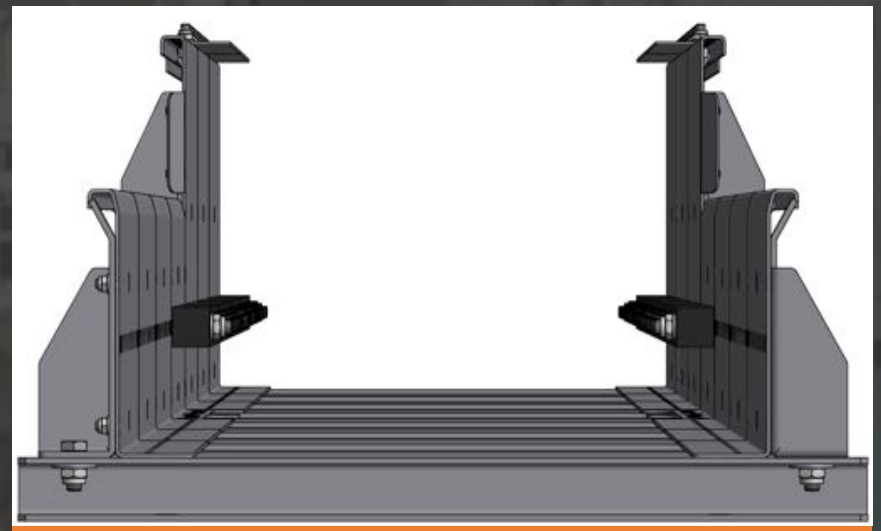
Supporting Components Ensuring System Longevity

- **Boom Hinge Alignment System**
  - Pin & bore style system used to ensure trough alignment when booming down
  - Limit switch signals trough alignment in cab

Supporting Components Ensuring System Longevity

- **Guide Trough System**
  - Use of “tall trough” and rise protection on the boom portion of travel
  - Covered trough systems serve multiple purposes
    - Rise protection
    - Weather protection



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Supporting Components Ensuring System Longevity

- **Continuous Flex Cable**
  - Made specifically for a continuous “rolling” flex
  - TPE jacketing
- Strain Relief
  - Installed on fixed and moving end
  - Clamps cables down to ensure cables remain in the “neutral axis”

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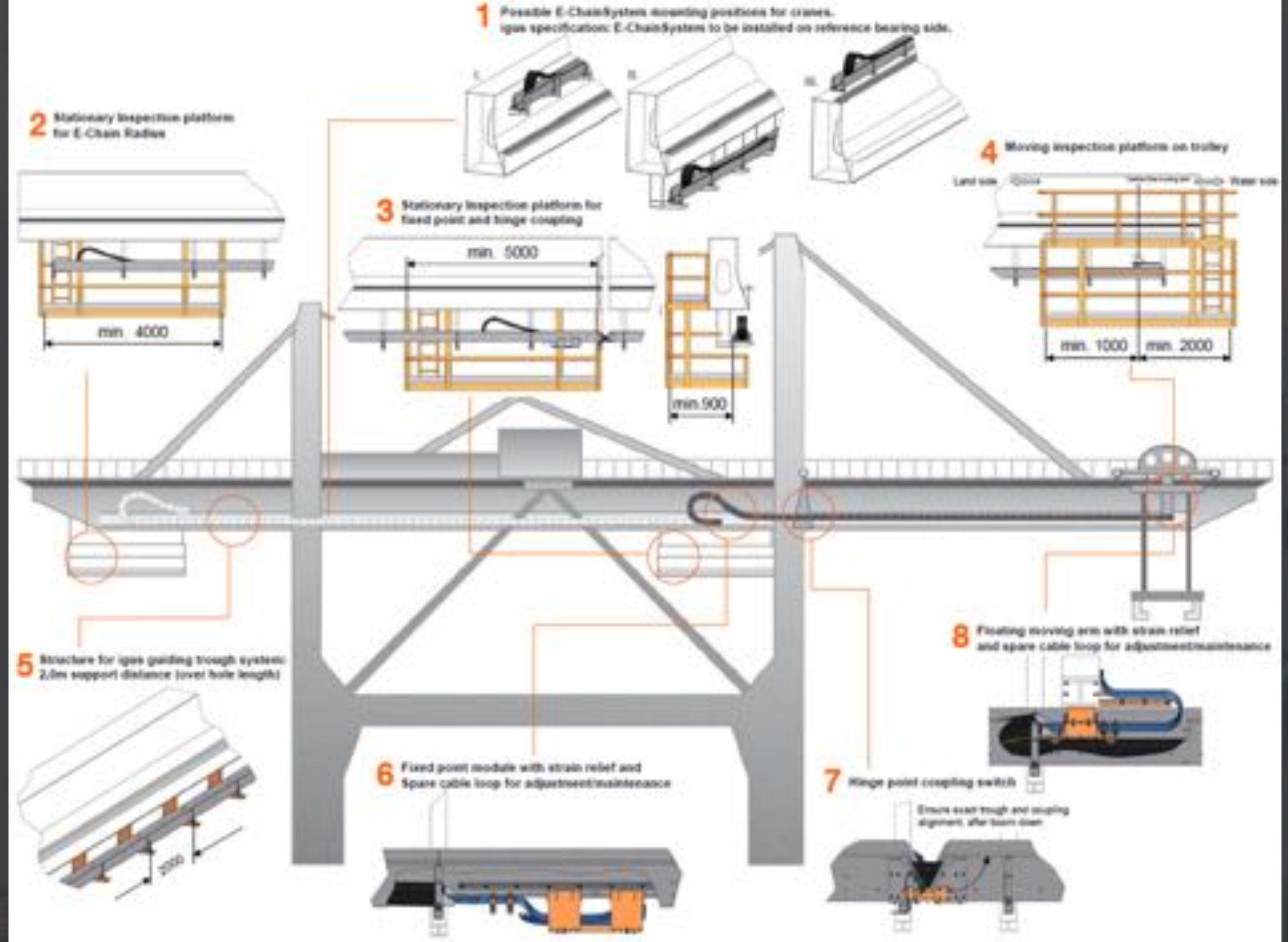
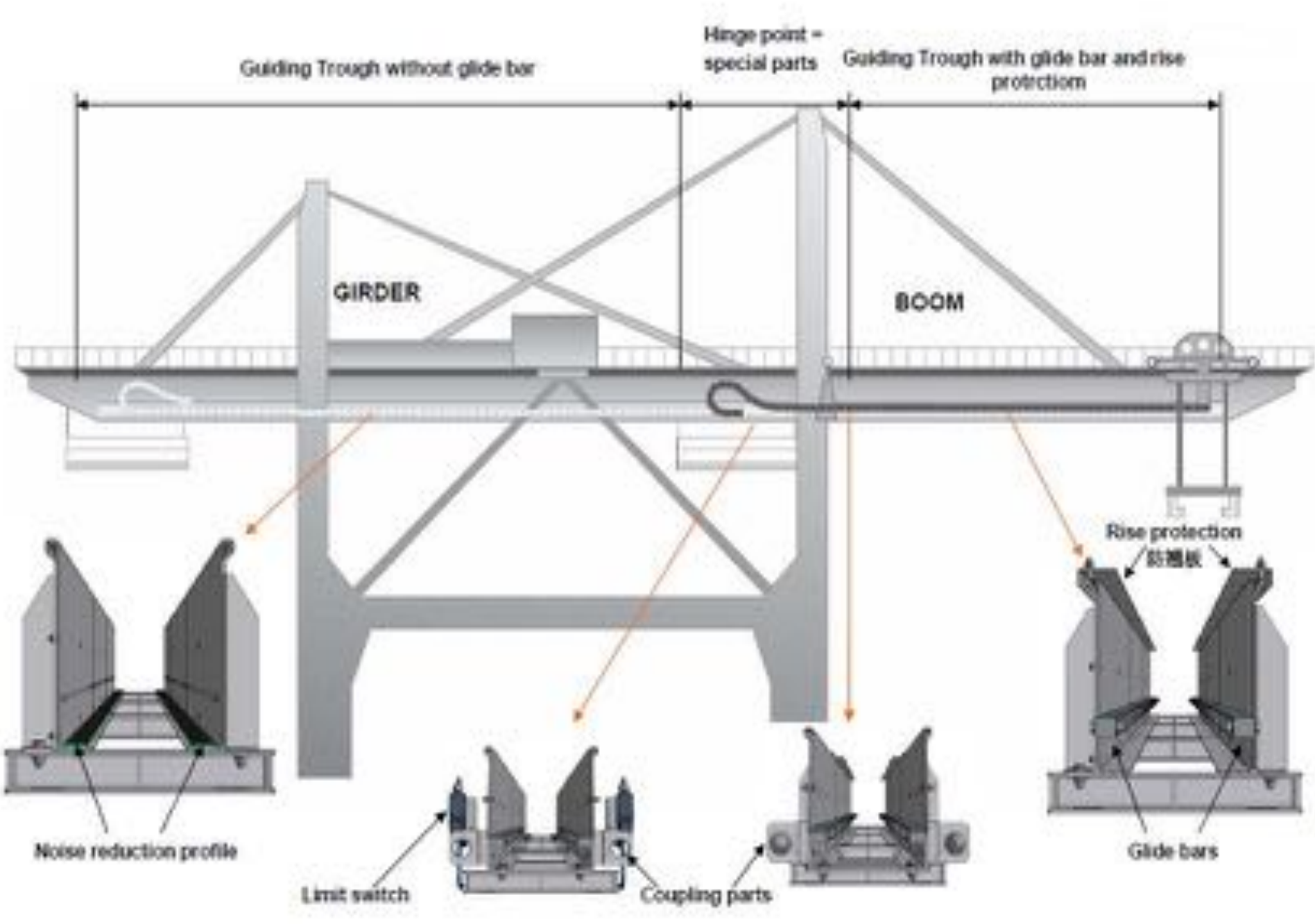
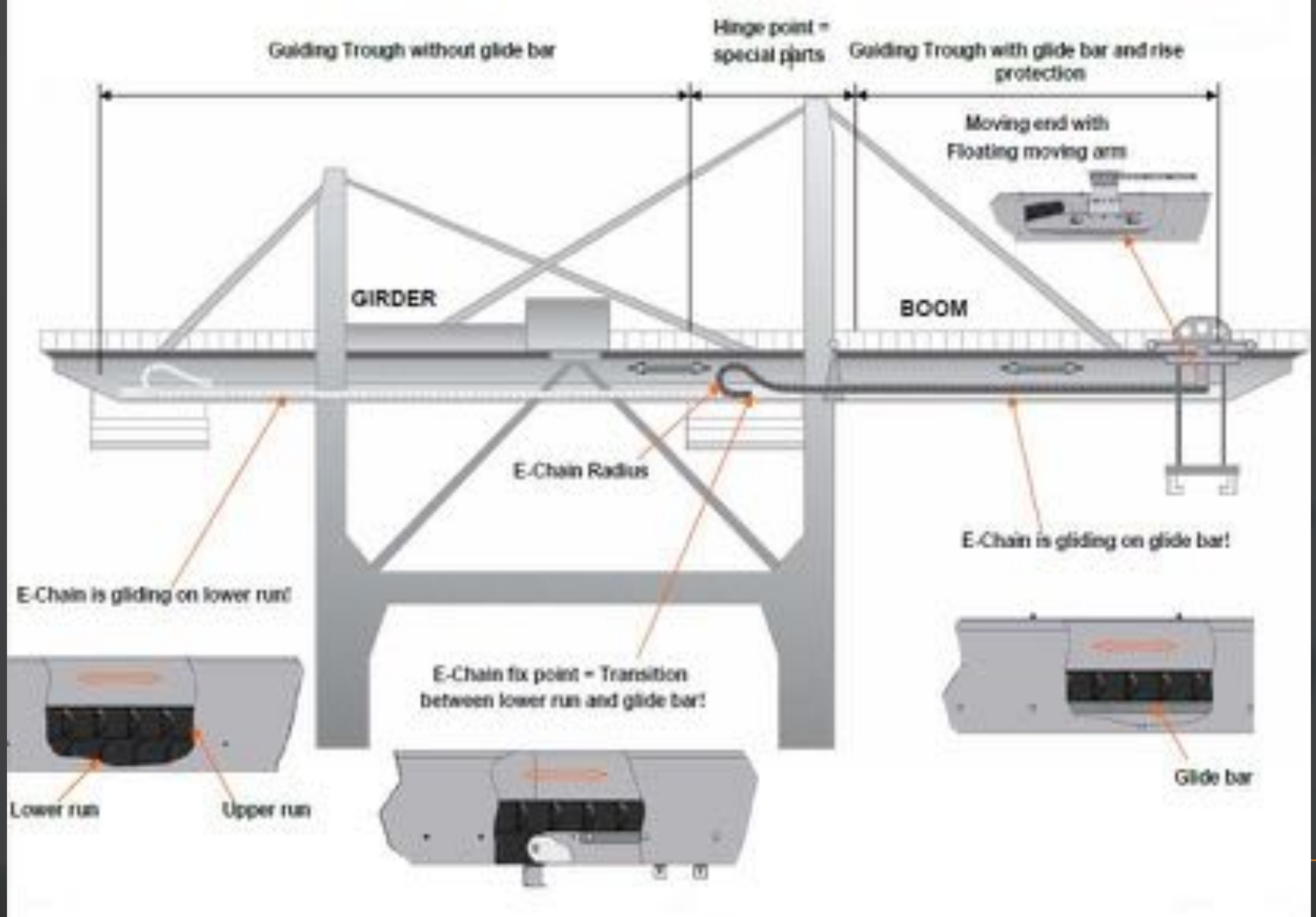

1 Possible E-Chain®system mounting positions for cranes.
igus specification: E-Chain®systems to be installed on reference bearing side.
2 Stationary inspection platform for E-Chain Radius
min. 4000
3 Stationary inspection platform for fixed point and hinge coupling
min. 5000
min.900
4 Moving inspection platform on trolley
Land side
Water side
min. 1000
min. 2000
5 Structure for igus guiding trough system: 2,0m support distance (over hole length)
6 Fixed point module with strain relief and Spare cable loop for adjustment/maintenance
7 Hinge point coupling switch
Ensure exact trough and coupling alignment, after boom down
8 Floating moving arm with strain relief and spare cable loop for adjustment/maintenance


Guiding Trough without glide bar
Hinge point – special parts
Guiding Trough with glide bar and rise protection
GIRDER
BOOM
Rise protection
Noise reduction profile
Limit switch
Coupling parts
Glide bars


Guiding Trough without glide bar
Hinge point = special parts
Guiding Trough with glide bar and rise protection
Moving end with Floating moving arm
GIRDER
BOOM
E-Chain Radius
E-Chain is gliding on glide bar!
E-Chain is gliding on lower run!
E-Chain fix point = Transition between lower run and glide bar!
Lower run
Upper run
Glide bar

Prolonging Service Life using Smart Plastics

- **iSense**
  - Predictive maintenance for polymer cable carrier
  - Allows real-time condition monitoring of systems in the field
  - Multiple ways to monitor system status through various components – both chain & cable

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What is iSense?

- **iSense** is a system that allows **real time condition monitoring** of chain systems in the field.

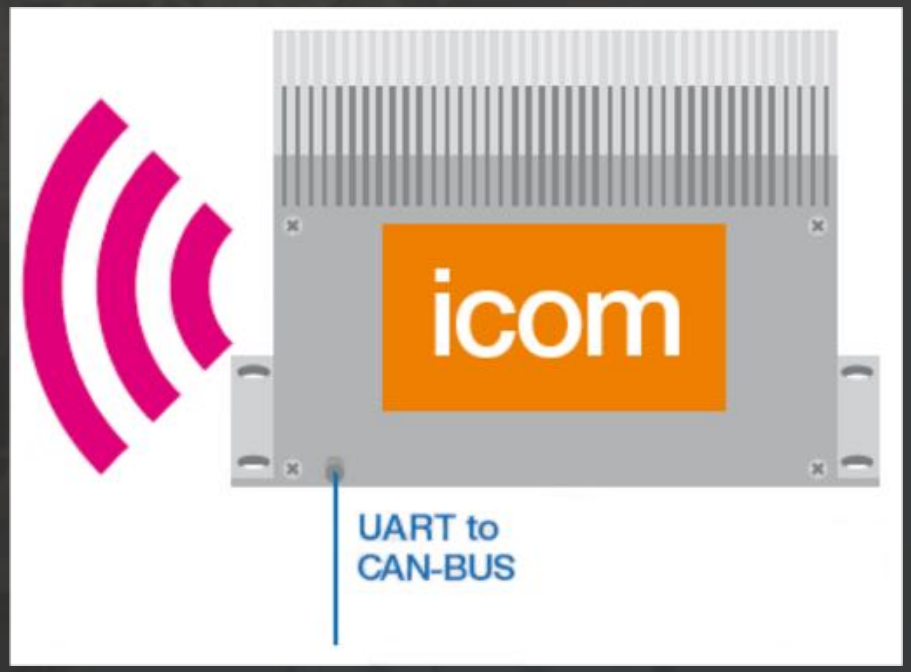
- The system consists of different types of **sensors, control modules, a communications module** and more importantly, our **database filled with 20 years of testing data and service life calculating algorithms.**

- The system can be used to **monitor and find small problems before they become critical problems** by detecting abnormal operation and creating alerts.

- This augments regularly scheduled inspections to allow **affordable monitoring** of mission critical equipment **24/7-365**

What **technology** is available?

- The **modular iSense system** allows for monitoring of the following conditions:
  - Chain System **disconnection of links**
  - Over/under **push pull force** values during operation
  - Chain System **wear and life prediction**
    - Cycle counting
    - Ambient temperature monitoring
    - Acceleration & speed monitoring
    - Pin/Bore and gliding surface wear measurements
  - **Rising of the upper run** of the E-Chain System due to blockage
  - **Cable tension** inside the E-Chain System
  - **Conductor life** inside cables



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What **capability** does it provide?

- **Emergency shutdown signaling** in case of failure event to prevent catastrophic damage
- Ability to configure "**trouble alerts**" based on abnormal operation that has not reached a failure state
- Online **24/7 visibility** to maintenance personnel – login from mobile devices
- **Dashboard "Fleet View" of all machinery and it's status**, maintenance intervals and any trouble alerts
- **Increasing accuracy of predictive maintenance** planning through machine learning – Updating algorithms **based on <u>your</u> conditions and <u>your</u> machinery use**

Thank You!

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