AnyLogic & AnyLogic cloud roadmap

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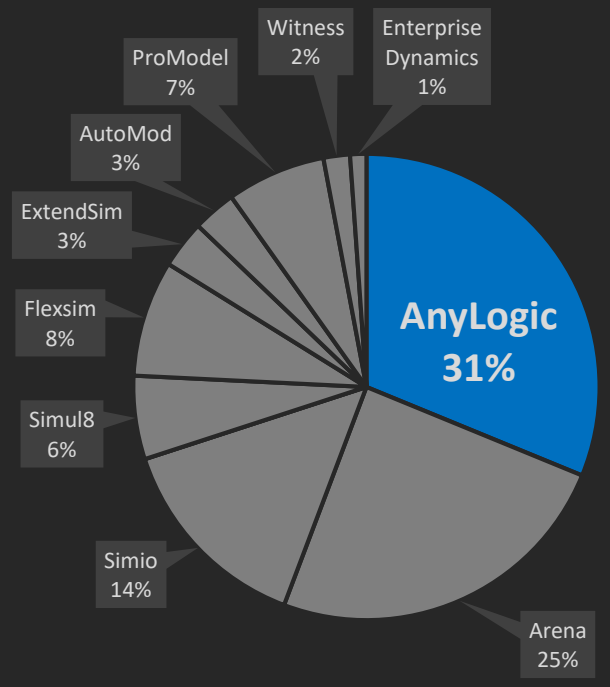
The AnyLogic Company

AnyLogic Conference 2019
April 17-18 2019
Austin, TX

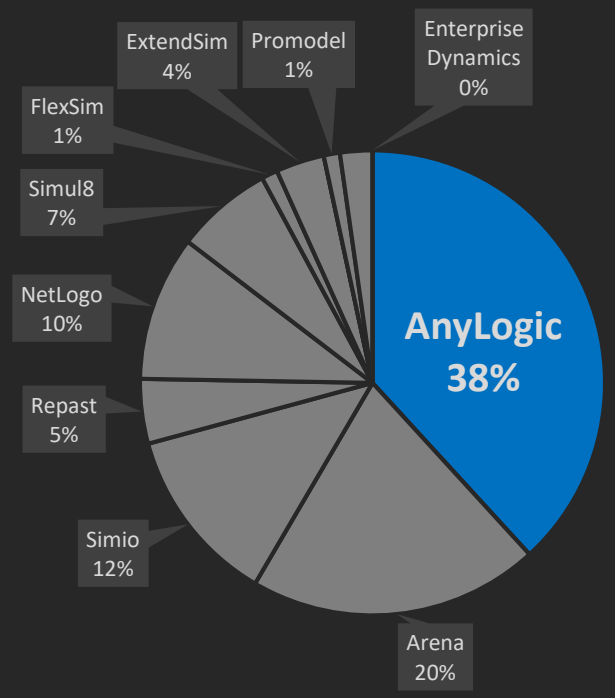
THE AnyLogic COMPANY

AnyLogic is doing great. Here's some recent stats:

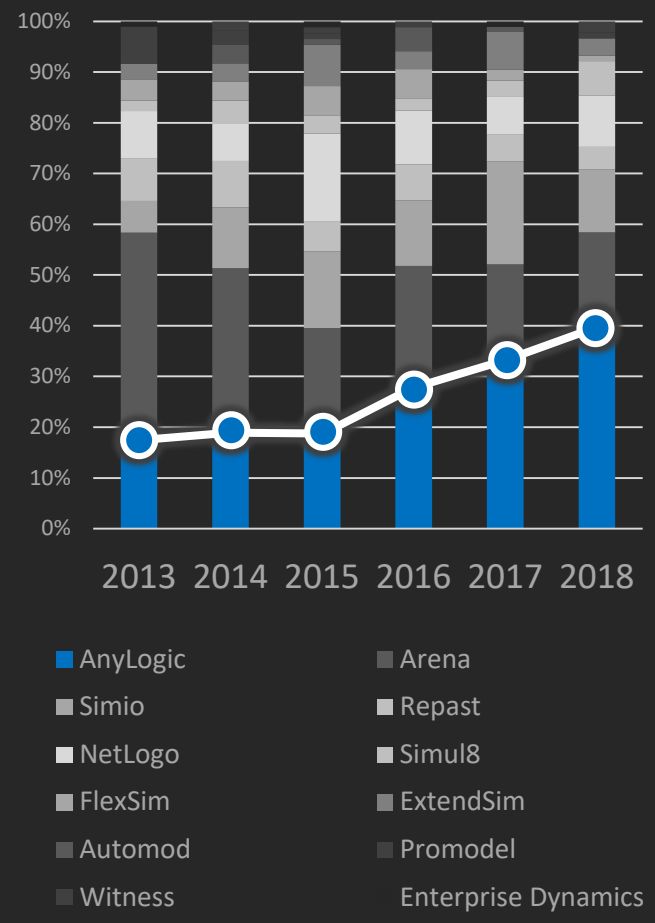
LinkedIn user group members as of December 2018



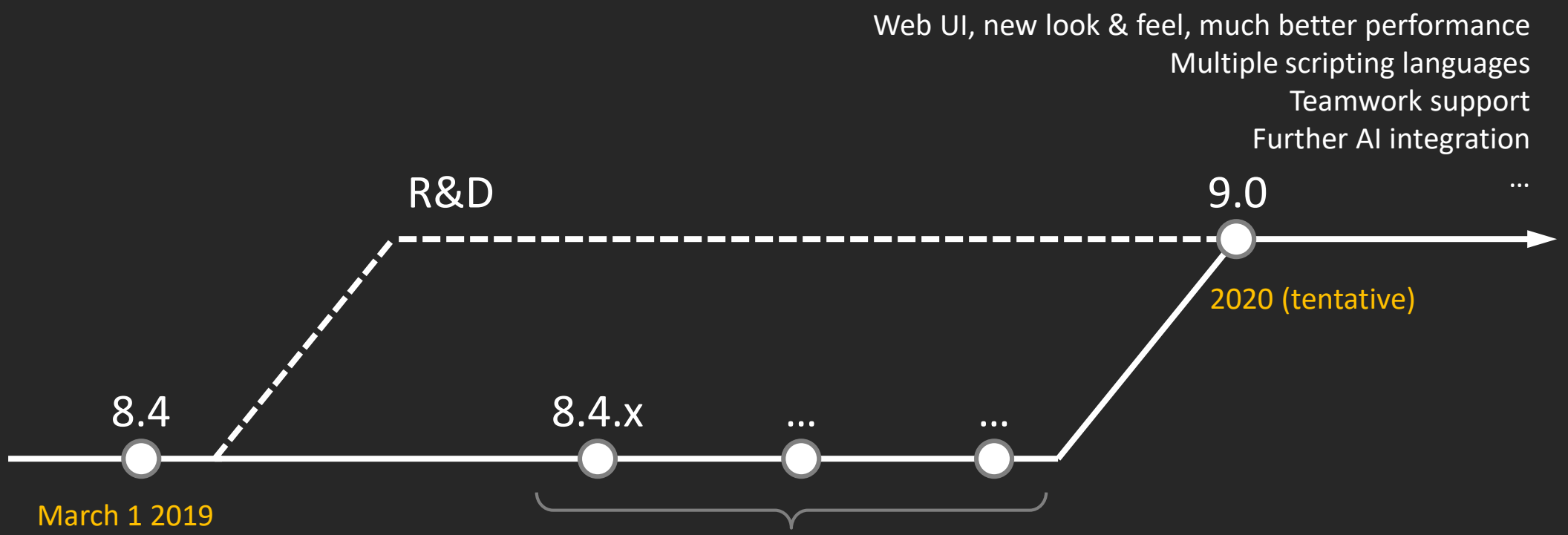
Case studies presented at WSC'18 (December 2018)



"Mind share" dynamics 2013-2018



AnyLogic roadmap 2019-2020 (desktop development tool)



March 1 2019

Material Handling Library:
- Transporters / AGVs in free space
- Jib crane, Lift, Conveyor spur
- Network port, dynamic networks & multi-tier networks

Files as resources & Excel as input in the Cloud

Improved animation performance, Events view returned

Export to standalone application from command line (Pro)

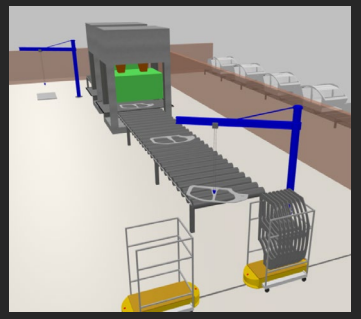
"Event-unaware" option for speeding up SD in AB models: getEngine().setEventAwareSolver(**false);**

Material Handling Library – more features

Minor improvements & bug fixes

Deep Learning integration thru Java

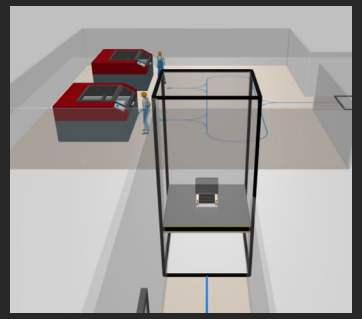
Material Handling Library 8.4 – new features / example models:



[jib crane]

Jib Cranes at Press Shop

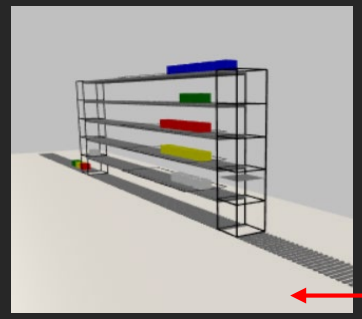
Crane (markup) is referenced by **MoveByCrane** block (for now, routing is not done through cranes, but will be)
See also **Blocked zone**



[lift]

Three Level Facility with Lift

Levels are visualized side by side on one canvas
Routing works seamlessly through the lift

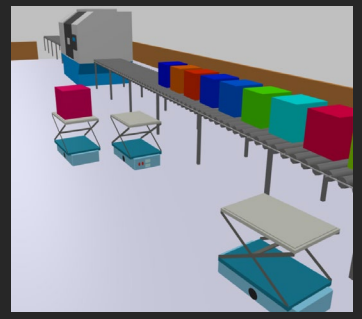


[lift]

Buffer with Lift

5 levels implemented by a replicated object BufferLines
Lift property **Main landing** – is on in main, off on levels

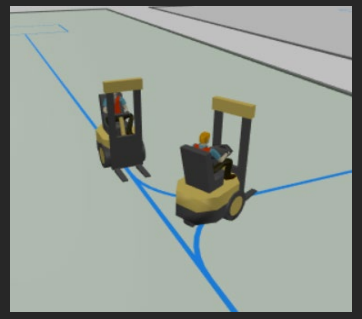
Dynamic creation of regularly structured networks



[free space]

Transporters Moving in Free Space

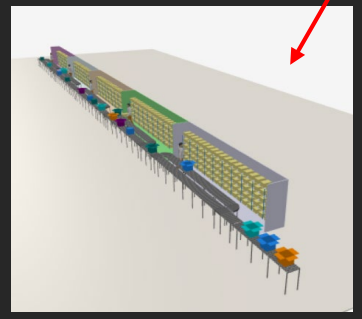
Walls, Racks & Conveyors are obstacles (see **Is obstacle** property)
TransporterFleet now has **Free space** option



[custom routing]

Passing with Oncoming Transporter

See **TransporterControl**: **Can enter node** and **Find path** (returns RouteData)
For simple cases see **Avoid paths** and **Avoid nodes** – dynamic lists, may depend on transporter & agent



[network port]

Order Picking Line

Replicated PickingZone contains **Network port** and is connected on startup to form a network
Network port can connect conveyors and paths (the latter will work for Transporters only, not for general agents)

Material Handling Library – further development 2019-2020

>> Phase I: March-April 2019

- Routing with included paths and nodes
- Reaction / resume time
- Heat map
- Changing priority of items queuing for Transporters
- Travel between levels and ability to use lift for free space Transporters
- Dynamically locked zones, doors, temporary obstacles
- Set speed and capacity on line with parameter (on model startup)

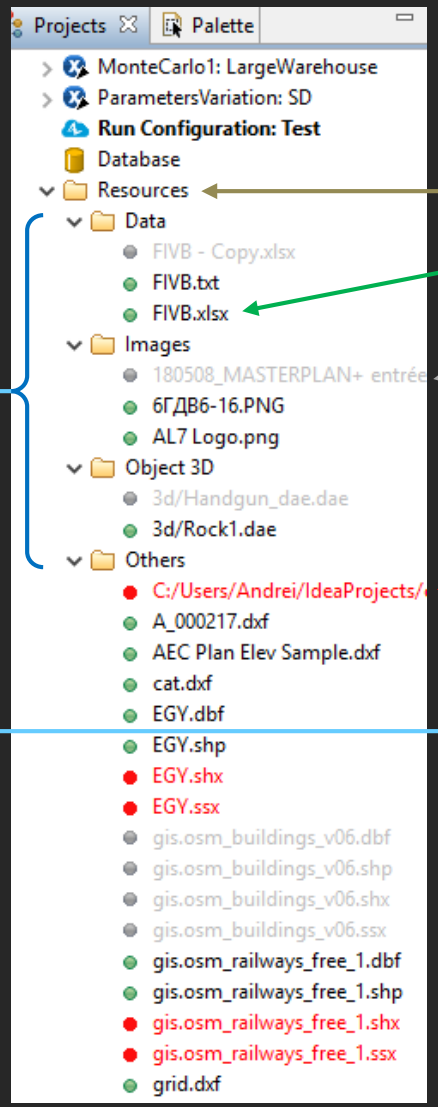
>> Phase II: Q3-Q4 2019

- Maintenance
  - *For all kinds of equipment*
  - *AGV charging*
- Bridge cranes
- New MHL Racks
  - *Slotting strategies*
  - *Integration with MHL Transporters & Conveyors*
- Zones for free-space Transporters
  - *Zones with limited capacity*
  - *Preferred paths*
- Assembler Station
- Good example models for all that stuff

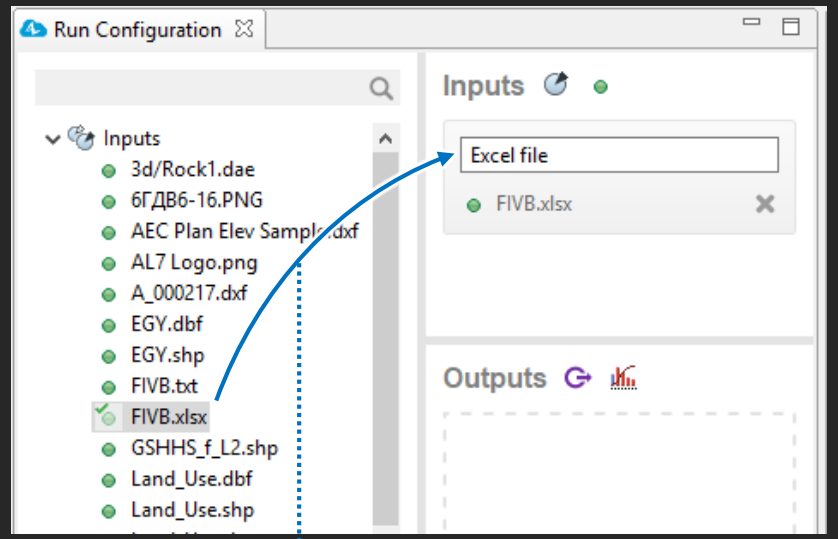
>> Phase III: end of 2019-2020

- Place holders
- Lift with capacity > 1
- Racks equipment
  - *ASRS*
  - *Shuttles*
  - *Dolly (?)*
- Rework current lane-guided routing
  - *Additional routing algorithms*
  - *Backward moving*
  - *Side movement*
  - *Spin turn on line*
- Zones
  - *Undesirable zones*
  - *Lockout zones*

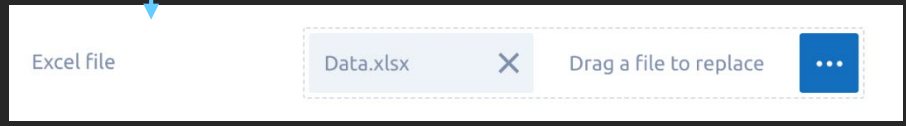
8.4 new feature: AnyLogic now takes care of files needed by the model



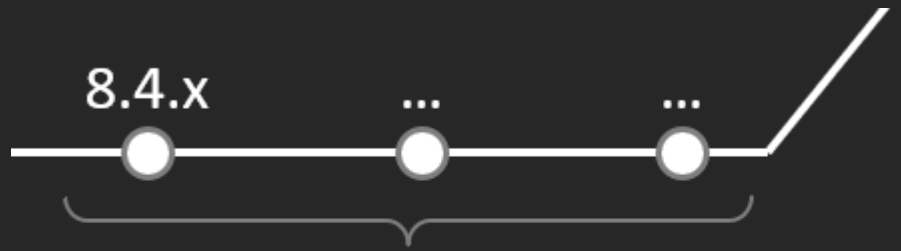
- All files present in the model folder and/or referenced by the model are shown in the model tree under Resources
  - If the file is present and referenced, it is green
  - If the file is present in the model folder but not referenced, it's gray (unless you explicitly say you need it)
  - If it is referenced but not present, it's red
- File resource are structured into categories:
  - Data: .txt, .xls, .xlsx,…
  - Images: .png, .jpg,…
  - Imported 3D Objects: .dae,…
  - Other: all other files (CAD, shapefiles,…)
- When the model gets exported (to standalone or to the Cloud), all files that are referenced AND are inside the model folder are exported as well
  - Unused files are not exported



- If a file is referenced and present, it can be dragged onto the Inputs area of Run Configuration
  - Then in the Cloud you will be able to change the default file by uploading a new one



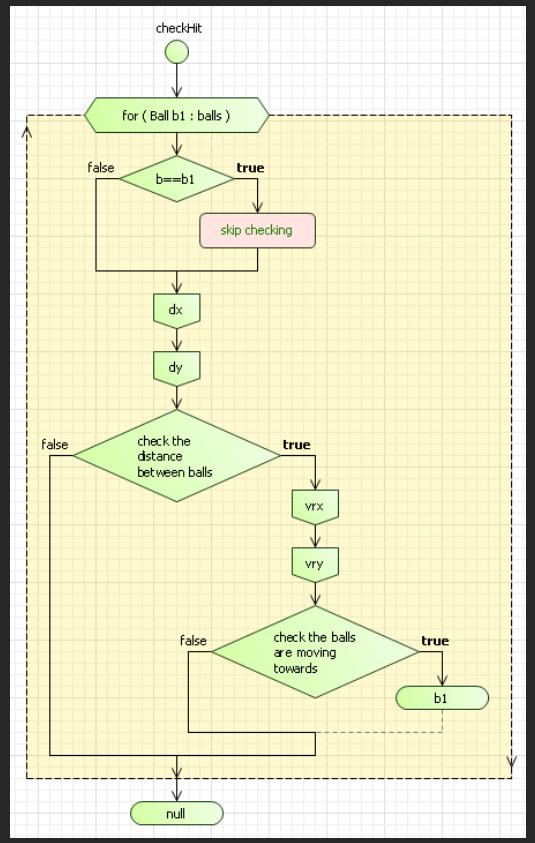
other things that will appear* before AnyLogic 9 is out



- Process Modeling Library resources
  - Dynamic change of task priority
  - Other improvements and fixes
- Layers in Graphical Editor
  - Layer is a logical level (“ground”)
  - Photoshop style editing)
- Navigation Panel element (TBD – maybe in 9.0)
  - Easy way to create stylish navigation bars
- Further animation performance improvements
  - We have a lot in the pipeline!
- CAD
  - Convert specific layers to space markup elements such as walls, etc.
- DRL integration through Java
  - Examples, instructions, …

*tentatively

the Action Charts case :)



- What happened:
  1. Infernally, we thought of Action Charts as of a useless feature: they do not simplify programming in AnyLogic and make the code less manageable
  2. The usage statistics available to us was telling they are not used much
  3. That was confirmed by the fact that nobody noticed the absence of Action Charts at runtime since 8.3.
  4. We decided to remove Action Charts forever and replace them with Java functions, which we did in 8.4 alpha
  5. To our surprise, that was met with active and strong resistance from a part of user community, including several influential users.
  6. Their point was that action charts are important to communicate the model decision logic to those who can't / don't want to look at the code.

- Decision:
  - Roll back and restore action charts at design time (8.4)
  - Then possibly show them at runtime as well, and even add some meaningful runtime info such as algorithm branch statistics

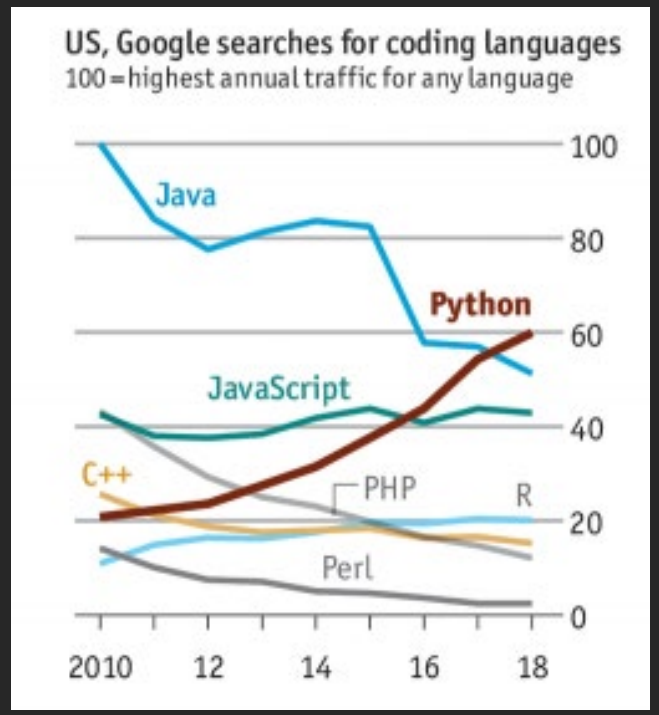
- Lesson learned
  - Even our support may not know all usage patterns of AnyLogic. Before removing functionality, communicate better with the community: surveys, LinkedIn, etc.
- For those who were worried about Action Charts: good news, we heard you, Action Charts are in!

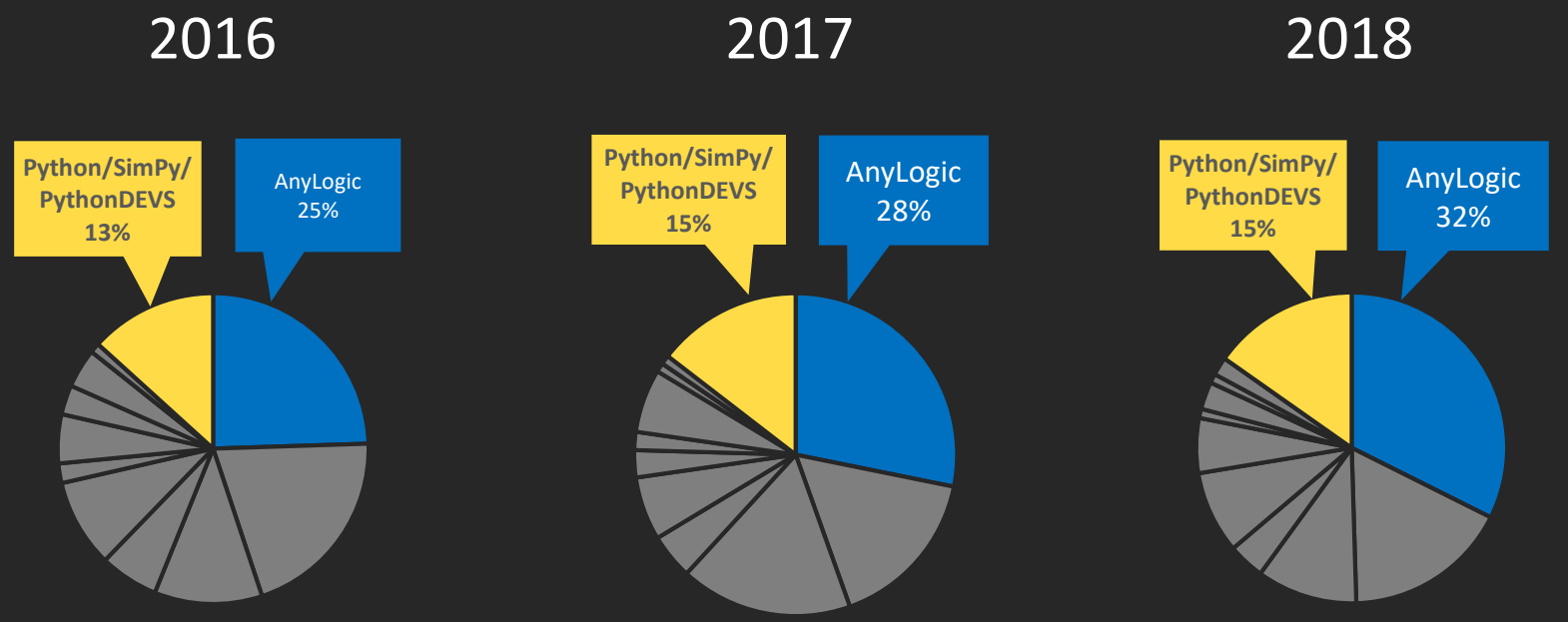
AnyLogic 9
2020*

*tentatively

python cannot be ignored any longer

- Python already dominates the analytics space
- We have to address it in AnyLogic (and that will open AnyLogic for more users!)
- (Java of course is here to stay:)





WSC “mind shares” with Python-based tools included

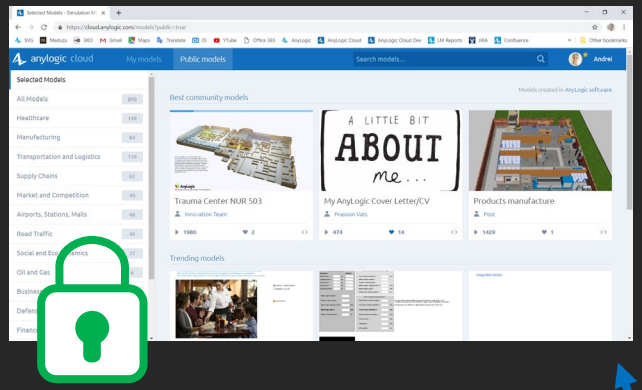
AnyLogic 9 highlights

- Modern, web style model development UI (old fashioned eclipse UI will be gone at last!)
  - Browser-based development UI – ability to run remotely & online as web app
  - Much better editor performance – by incremental on-the-fly code gen & other improvements
  - Better 3D editing (instant 3D preview as the first step)
- Both Python and Java are supported
  - We are now researching the options: have Python engine & libraries parallel to Java or map Python code written by the user to Java
- Merge concepts & stay minimalistic wherever possible
  - Markup merge: Area = Node, GIS route = Path, GIS region = Polygonal Node, etc.
  - Space merge: Pedestrian space = Transporter space, Train movement in GIS, etc.
- True teamwork support
  - One class – one file, GIT support, merge conflicts

what is AnyLogic Cloud?

AnyLogic Public Cloud

A free web service where anybody can run models and anybody who has AnyLogic can upload & manage models



AnyLogic Public Cloud Subscription

For a small annual fee users can get extended CPU power, unlimited run time, API usage, and access to external resources in the Public Cloud

AnyLogic Cloud API

JavaScript, Java, and Python API to invoke and control execution of Cloud-based simulation models from custom web pages or applications. Python API is coming

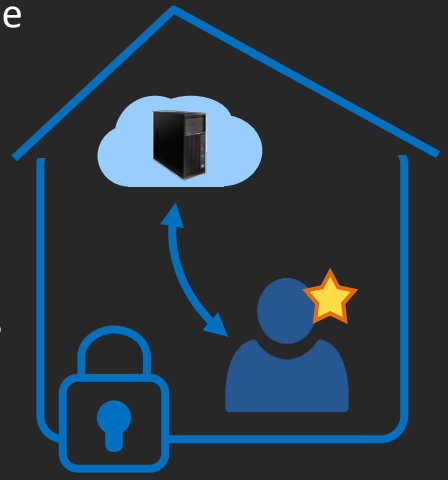
AnyLogic Cloud API is available for subscribers and Private Cloud users

AnyLogic Private Cloud

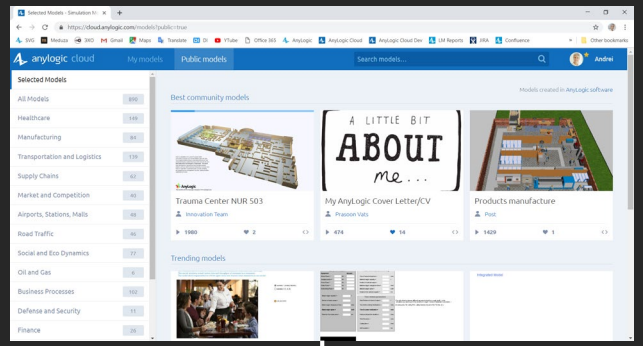
A product that installs on multiple servers / nodes. It hosts and allows to upload, manage, and run simulation models. The functionality and web UI are the same as in the Public Cloud

AnyLogic Private Cloud Lite

A product with the same functionality as the AnyLogic Private Cloud, but allows to use only one server and up to 16 cores. Installs in one click on a Windows machine



you may consider Cloud as a wrapper around the model with many APIs



Custom & branded web UI

Your analytical workflow, DB, custom BI…

AI (learning agents) etc. …

..any kind of REST client

Default AnyLogic Cloud UI

JS API

Java API

Python API

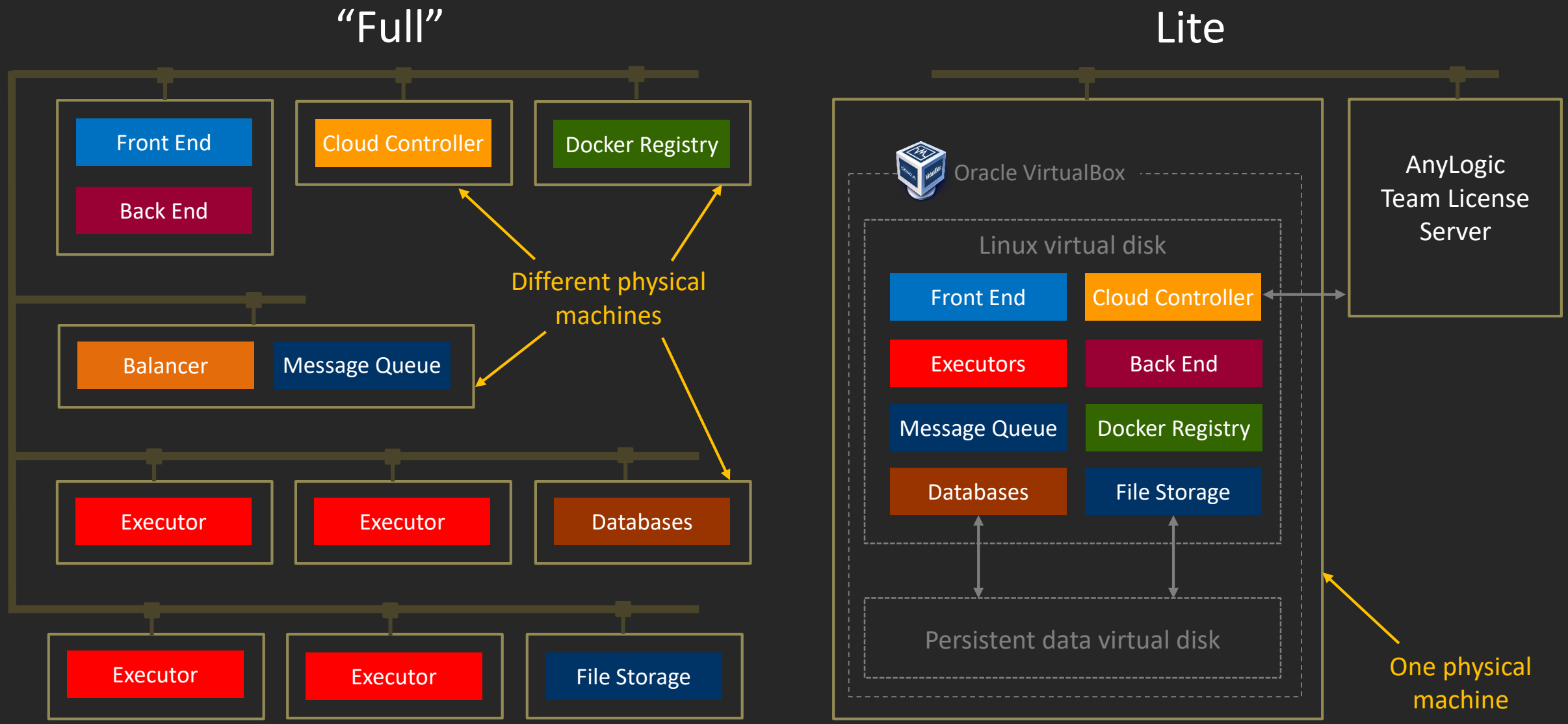
Web server / RESTful API

User, version, data, run manager

AnyLogic model (Java)

anylogic cloud

AnyLogic Private Cloud architecture



AnyLogic Cloud technical specifications

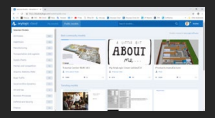
Simulation run (no animation) / Multi-run / Animation

	Access to models	Internet access	API access	Servers	Model memory	Execution time
Any user	Pu	No	No	General pool	2GB	1 / 30 / 5 min
User under mtce	Pu / Pr	No	No	General pool	2GB	1 / 30 / 5 min
Subscription Plan	Pu / Pr	Yes	Yes	Subscription pool	4GB	unlimited
Private Cloud Lite	Pu / Pr / L	Yes	Yes	1 * 16 cores	unlimited	unlimited
Private Cloud	Pu / Pr / L	Yes	Yes	unlimited	unlimited	unlimited

Pu – Public
Pr – Private, controlled by developer
L – Local, limited to corporate intranet

case 1 where else would you host the model used operationally?

- Someone has developed a model for you that you are going to continue using / use periodically
  - Scheduling and planning applications, e.g. production scheduling, inventory management, demand forecasting tools, etc. – there are many cases when the model is used on a continuous basis and needs a reliable hosting/execution platform



Web UI

JS API

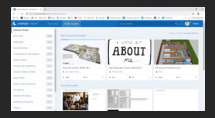
Java API

API

- Where are you going to store and run that model?
  - On the modeler's laptop or desktop? Of course, not :)
  - On a corporate server, exported as a standalone Java application? No, you do not want to rely on your sysadmin skills to setup the environment, etc. for the model – each time you upgrade it!
- AnyLogic Private Cloud is a secure, reliable, and efficient environment to store the models (optionally, with the source files), update, and execute them – both manually and programmatically

case 2 you are a consulting organization, want to leave the model

- You have developed a model for someone and wish to leave the model with the client, but client does not have AnyLogic licenses…
  - …and does not want to buy any or develop internal competence in modeling
  - You however have a maintenance contract and will be upgrading / fixing the model from time to time
- How would you actually deliver the model and install it at the client site?
  - On the client's server, exported as a standalone application?
    Then again you will have the trouble of communicating with the system administrator, this time someone else's.
- You offer AnyLogic Private Cloud Lite (or "full" in case of many users or heavy simulations) together with your consulting services and it ensures reliable multi-user access to the models for the client and ability to easily manage and upgrade the model for you



Web UI

JS API

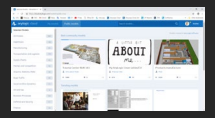
Java API

API

case 3 one model – multiple users (or remote users)

- A model has been developed in your organization. And there are multiple users of that model – other employees, management, or external customers. Or you want to quickly let someone remote run it

- How would you set it up?
  - Would you export it and install on each user's workstation? No, this may not even be possible under some corporate policies. Even sending the exported files may be a challenge. Not to mention different OSes!
  - If you install the exported model on a server as a Java application – who will manage access rights, virtual machines, safe parallel execution, etc.?



Web UI

JS API

Java API

API

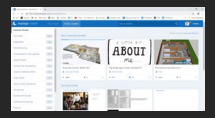
- Upload models to the AnyLogic Cloud and then use standard web UI to set up inputs, configure experiments, create dashboards, and download results.
  - Manage access rights from your user profile.
  - And as a bonus: once somebody runs a certain scenario, the outputs are stored you next time someone decides to run the same case, they are readily available

case 4 heavy experiments run faster in the cloud (and give mobility)

- Your simulation got complex and heavy and takes e.g. 20 min to complete a run. And then you need to perform e.g. parameter variation (Monte Carlo, sensitivity analysis, …)

- Would you leave your laptop working over night or weekend?
  - No, you want to close it and take home, on the plane, etc.
  - Neither do you want to run it on your workstation and watch / control via remote desktop
  - Even if you are OK with that, a regular machine only has up to 16 cores

- Simply submit your simulation to the Private Cloud and run it there
  - Much more efficiently, multiple nodes & cores are utilized
  - Results of all runs are there in perfect order, downloadable, can't be lost
  - Results of already executed runs are reused
  - You can watch / control execution and completion



Web UI

JS API

Java API

API

case 5 create your own SaaS on top of Cloud based simulations

- You have developed a simulation-based inventory management tool and you want to sell it as a service. You want to have a cool custom UI with login, password, and dashboard. Inputs are custom controls & Excel files uploaded by the user. You also want to expose the model animation

Web UI

JS API

Java API

API

- Do you want to program your cool UI in Java Swing?
  - No, unless you want to deliberately torture yourself and frustrate your client
- Do you want to run your model on a workstation or standard server?
  - No, otherwise you would need to manage parallel access / parallel execution
- You upload your model to AnyLogic Cloud and build your cool web UI
- And use JavaScript API of AnyLogic Cloud to invoke the model, setup inputs, and embed animation if needed
  - Excel files can be used as inputs for Cloud Based models since AnyLogic 8.4

case 6 use simulations to train and/or test your learning agent

- You want to train a neural network in a safe risk-free environment. Or you already have a trained network and want to test it.
- AnyLogic naturally is THE tool where you can rapidly create a dynamic simulation model of virtually any kind of environment your neural network is planned to learn from / to work in
  - In case of Reinforcement Learning (or in the testing mode) the learning agent works in the loop with the simulation model
  - In case of Supervised learning the simulation model generates a series of data that is then labeled.
- AnyLogic Cloud abstracts away from the model implementation language and exposes rich Python, Java, and other APIs on top of RESTful API
  - This enables easy integration into Deep Learning frameworks

Web UI

JS API

Java API

API

case 7 distributed simulation

- You have a model that takes too long time to run and/or consumes too much memory. On the other hand, you know how to partition the model into multiple smaller models that could be run in parallel for most of the time and should be synchronized and exchange information not too often
  - For example, a pandemic model with multiple cities and inter-city flights
  - Or a supply chain model with highly detailed inside-4-walls components

Web UI

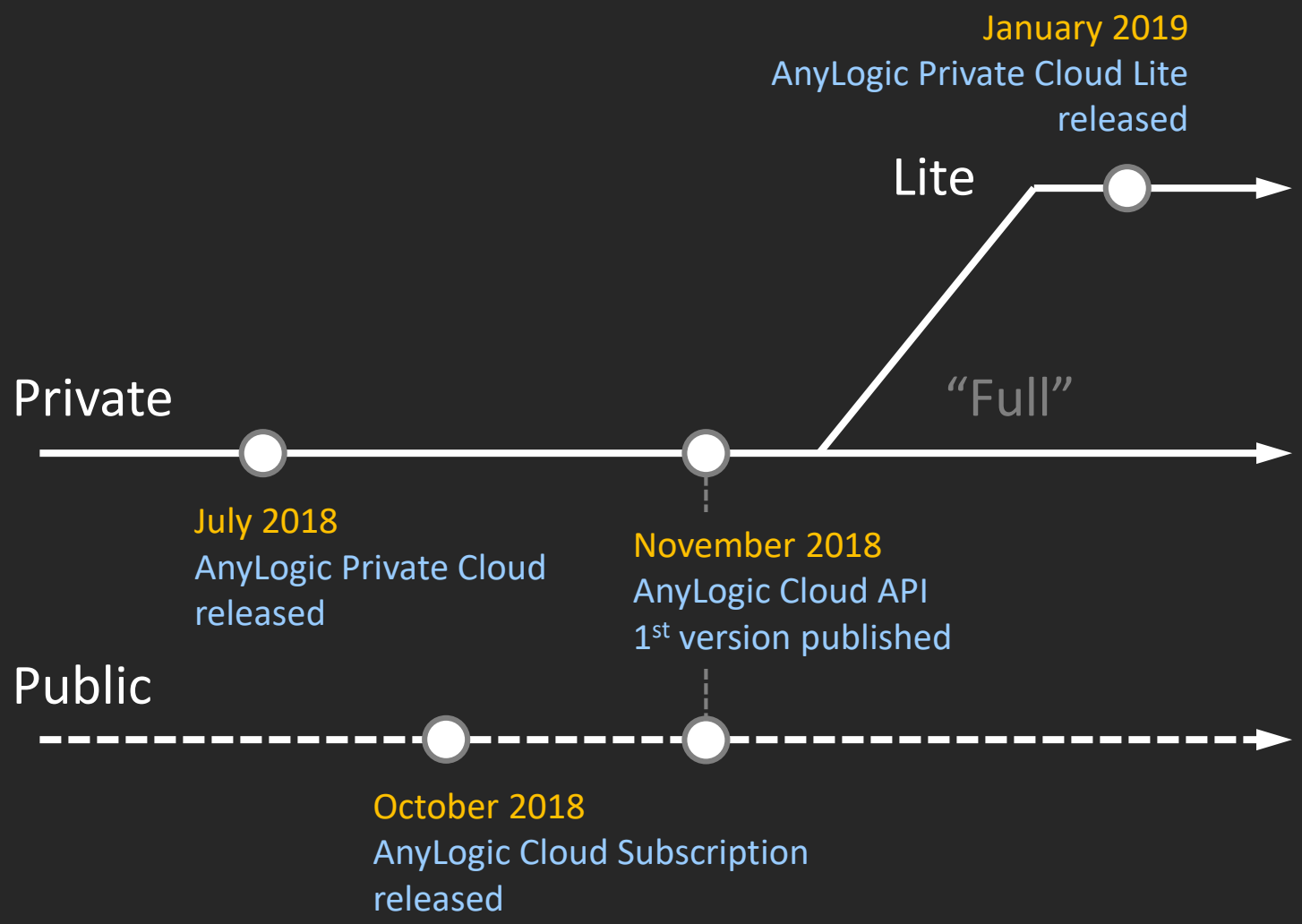
JS API

Java API

API

- As a modeler, you can divide the big model into multiple smaller models. But do you want to program their deployment to multiple servers, parallel execution and communication?
  - Of course not! You do not want to become a hardcore backend developer :)!
- You upload all sub-models into AnyLogic Cloud and use JS, Java, or Python API to let them run for a known time period, pause them to exchange information, and run again

AnyLogic Cloud products – release history & next steps



- Python API
- JavaScript and Java API
  - Further Improvements & extensions
- Administrator's dashboard
  - Web UI to inspect & control the state of Private Cloud
- Documentation & examples
  - Cover all possible use cases
- We will be with you, helping you to use the Cloud and exploring your use cases and needs
  - And make the Cloud better!

Thank you!