

# ROS在自动驾驶的探索和实践

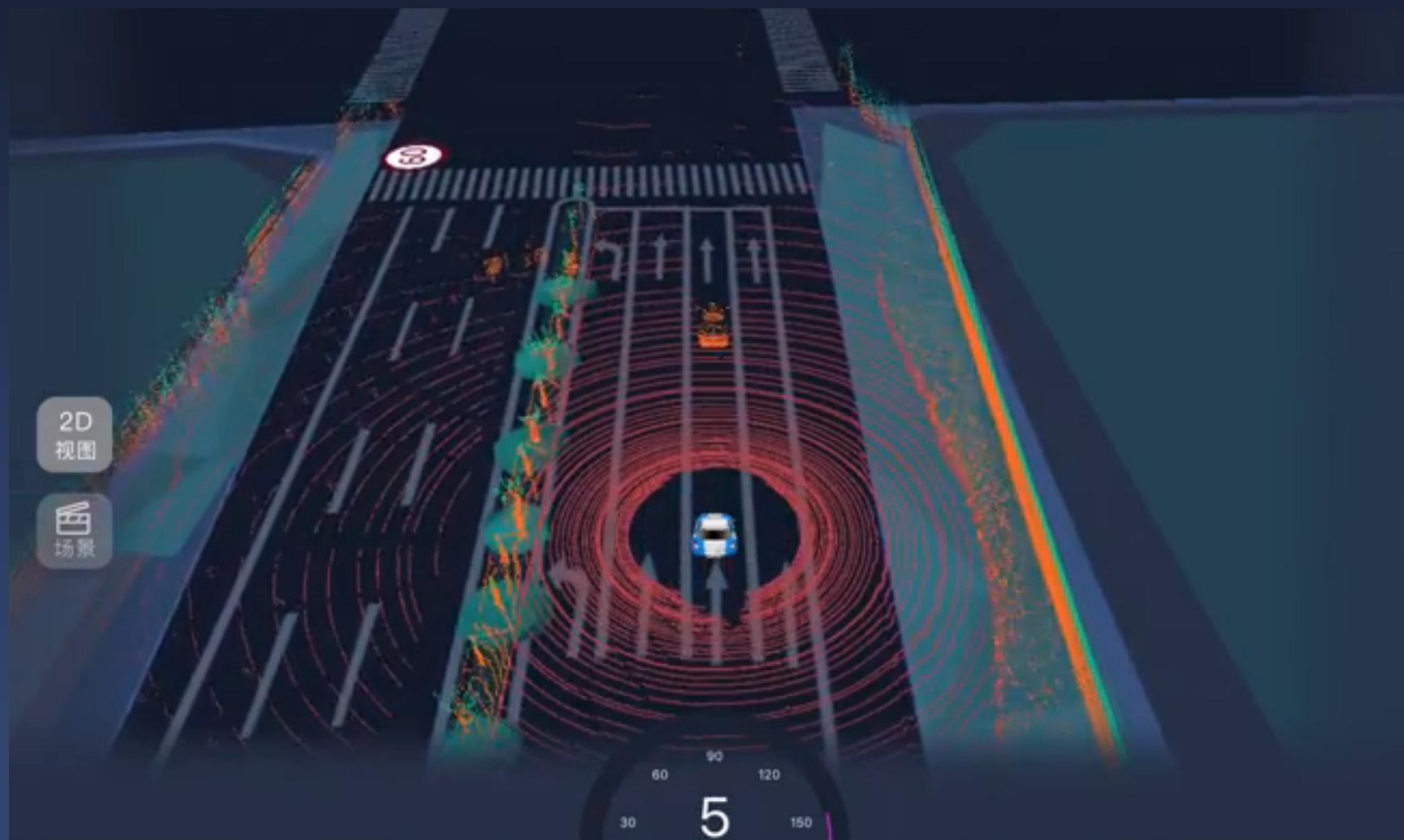
何玮



- 背景介绍
- Apollo中ROS的改进
  - 通信性能优化
  - 去中心化网络拓扑
  - 数据兼容性扩展
- Apollo框架使用



## 自动驾驶 – 一个复杂的系统性工程



## 对框架有哪些要求？

- 高效的开发支持
- 模块灵活配置
- 丰富的调试工具



为什么是ROS？

- 开发工具包
  - 完整的包管理和工程结构
  - 庞大的基础库
  - 多语言接口支持
- 计算调度模型
  - 消息驱动的运行模型
  - 抽象的通信接口
  - 自定义的消息格式
- 调试工具
  - 可视化的调试工具
  - 消息查看、存储、回放工具



ROS主要工具包

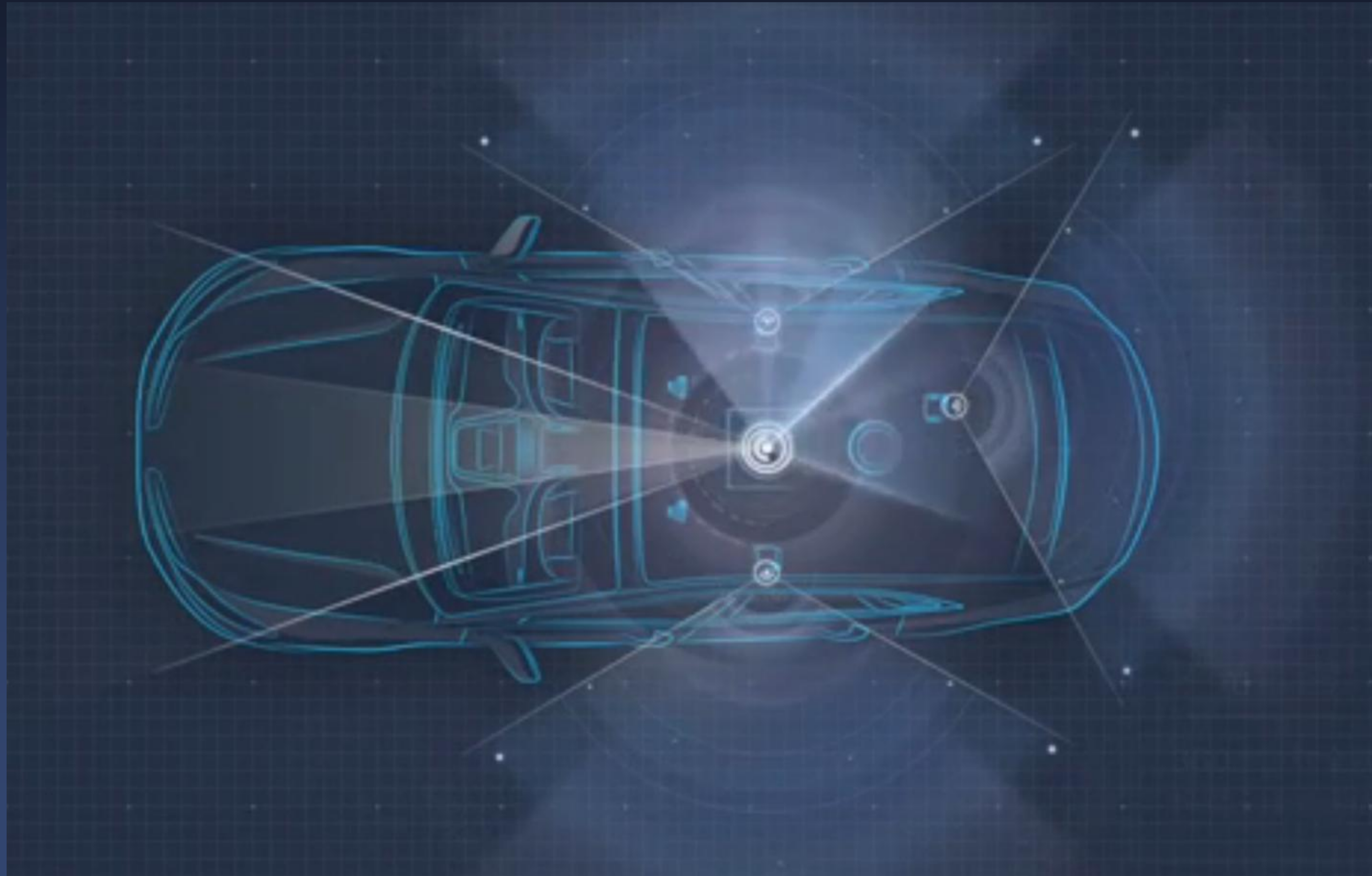
## ROS是否能满足工程需求？

- 大数据量传输性能瓶颈
- 中心化的网络存在单点风险
- 数据格式缺乏后向兼容

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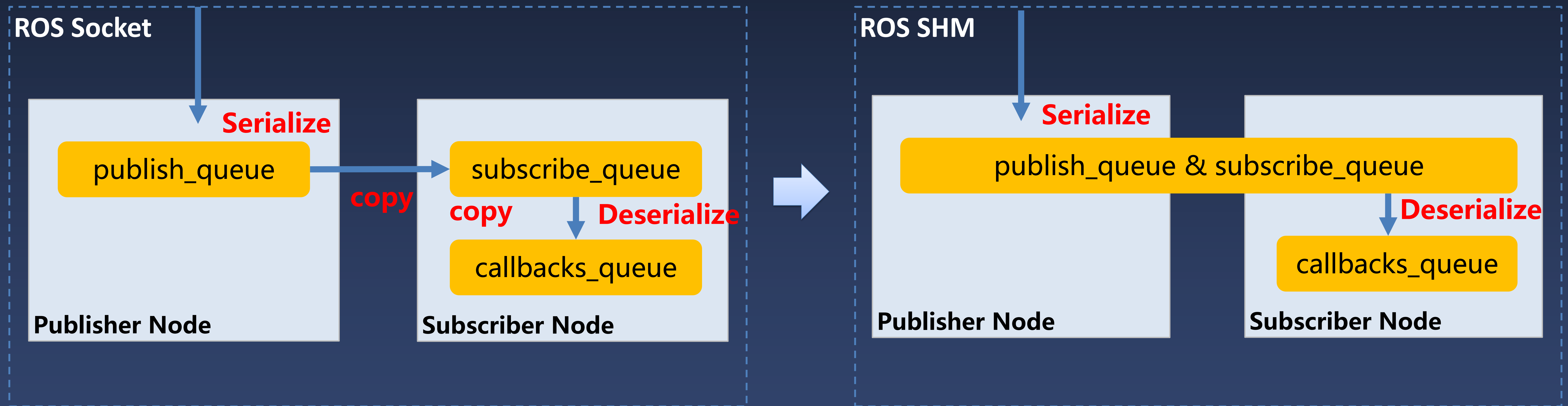


## 自动驾驶大量使用传感器引发很大的传输带宽需求





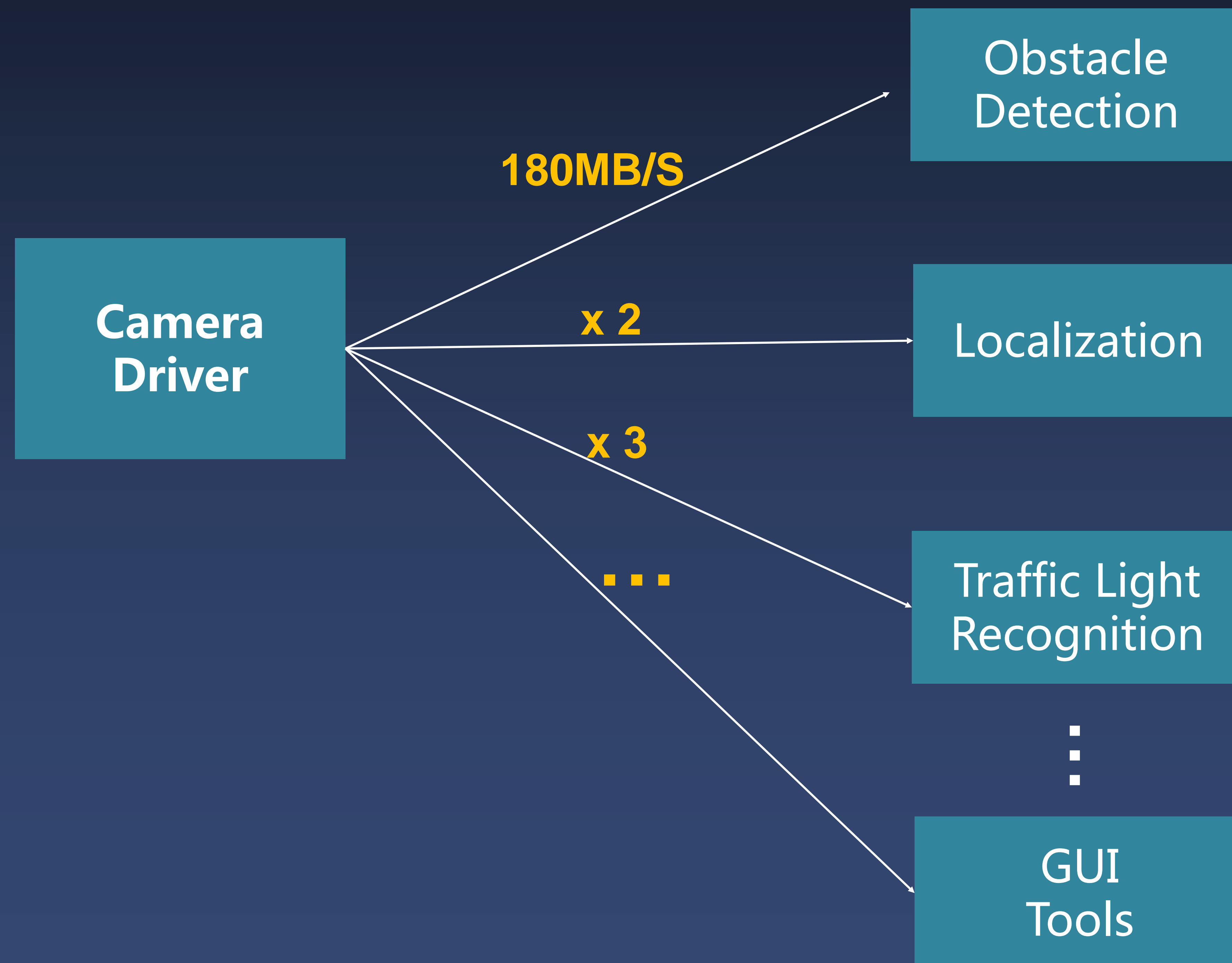
共享内存能减少传输中的数据拷贝, 显著提升传输效率



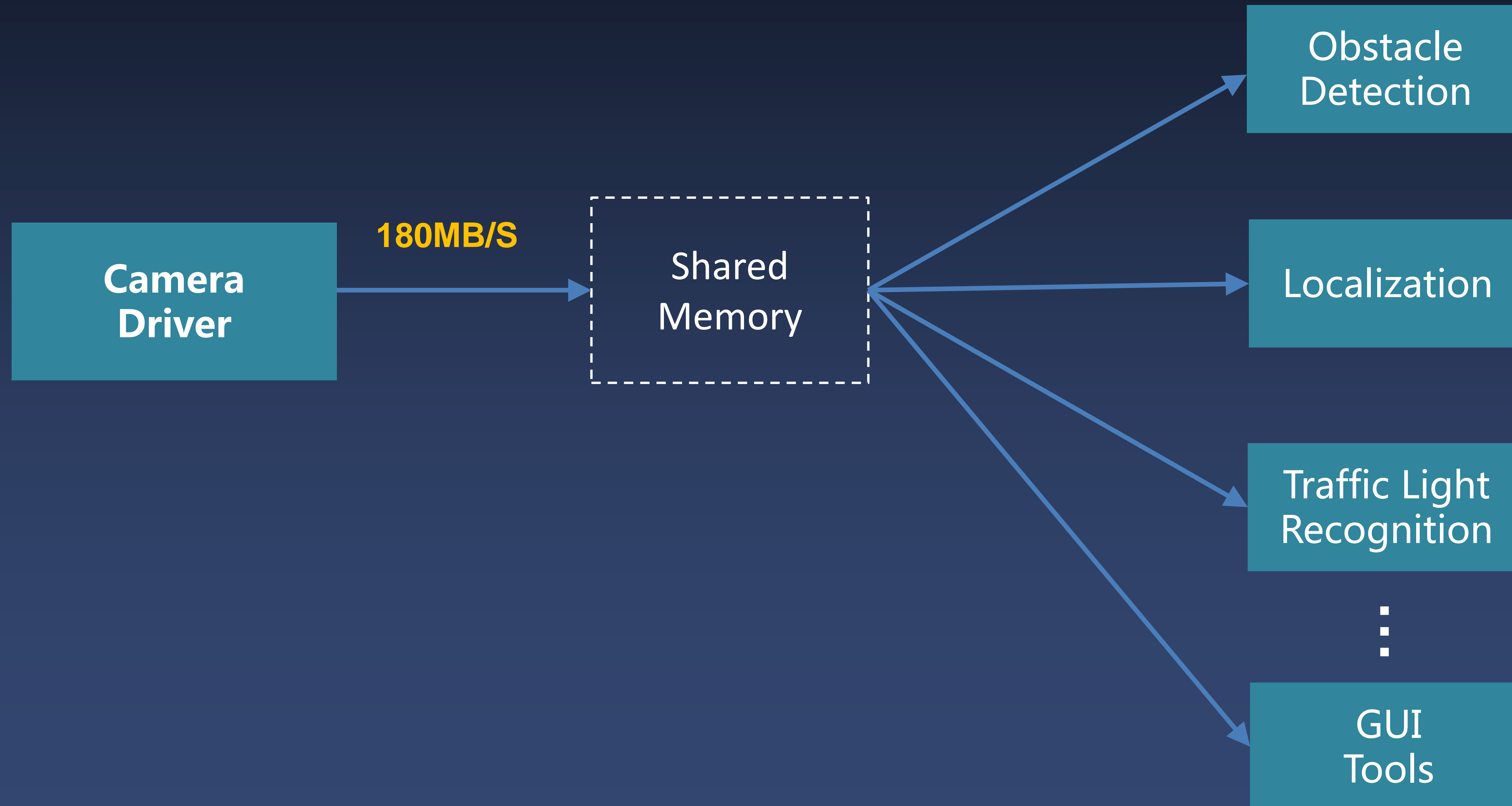
原生ROS Socket通信

无人车ROS共享内存通信

## 单路传感器消息有多个消费者时负载更是成倍增长



## 共享内存可以有效满足一对多的传输场景

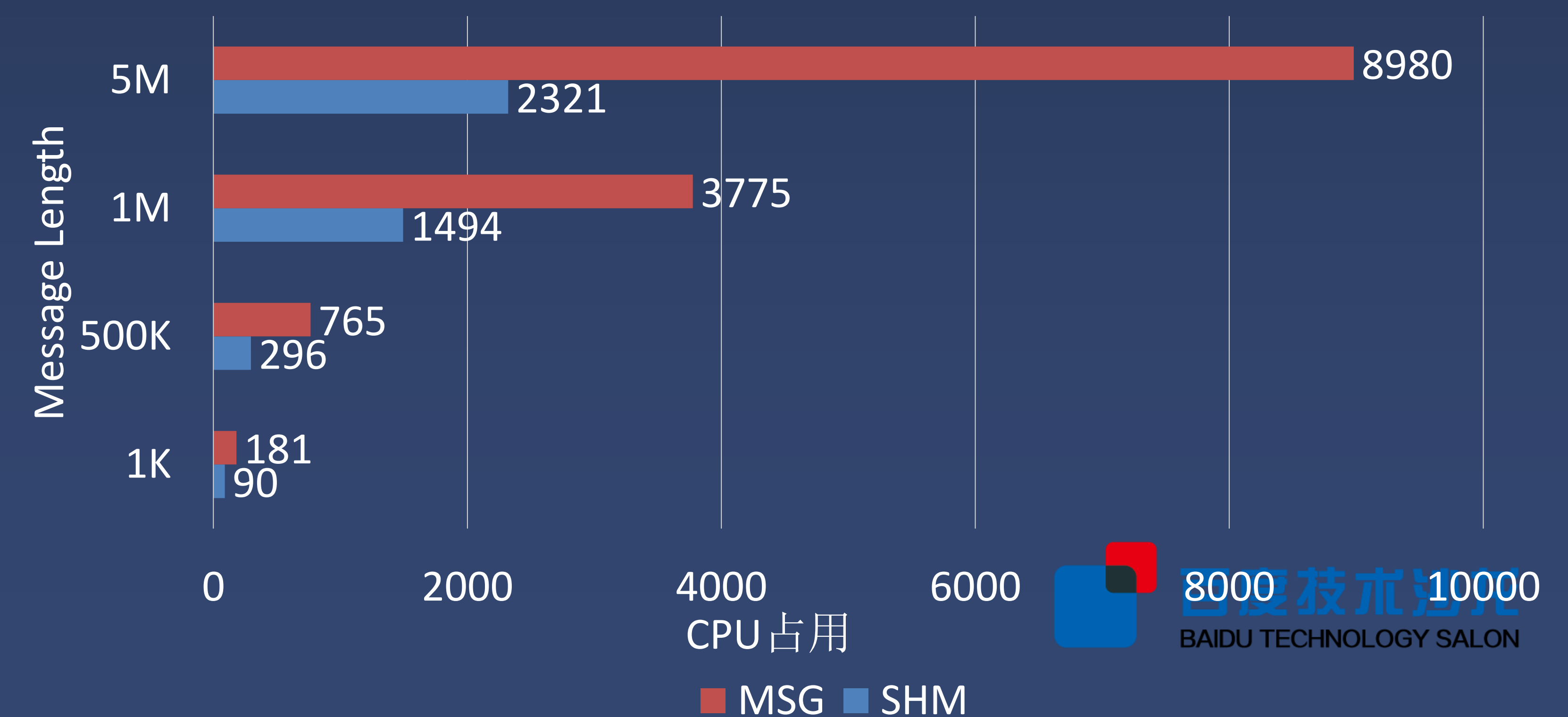
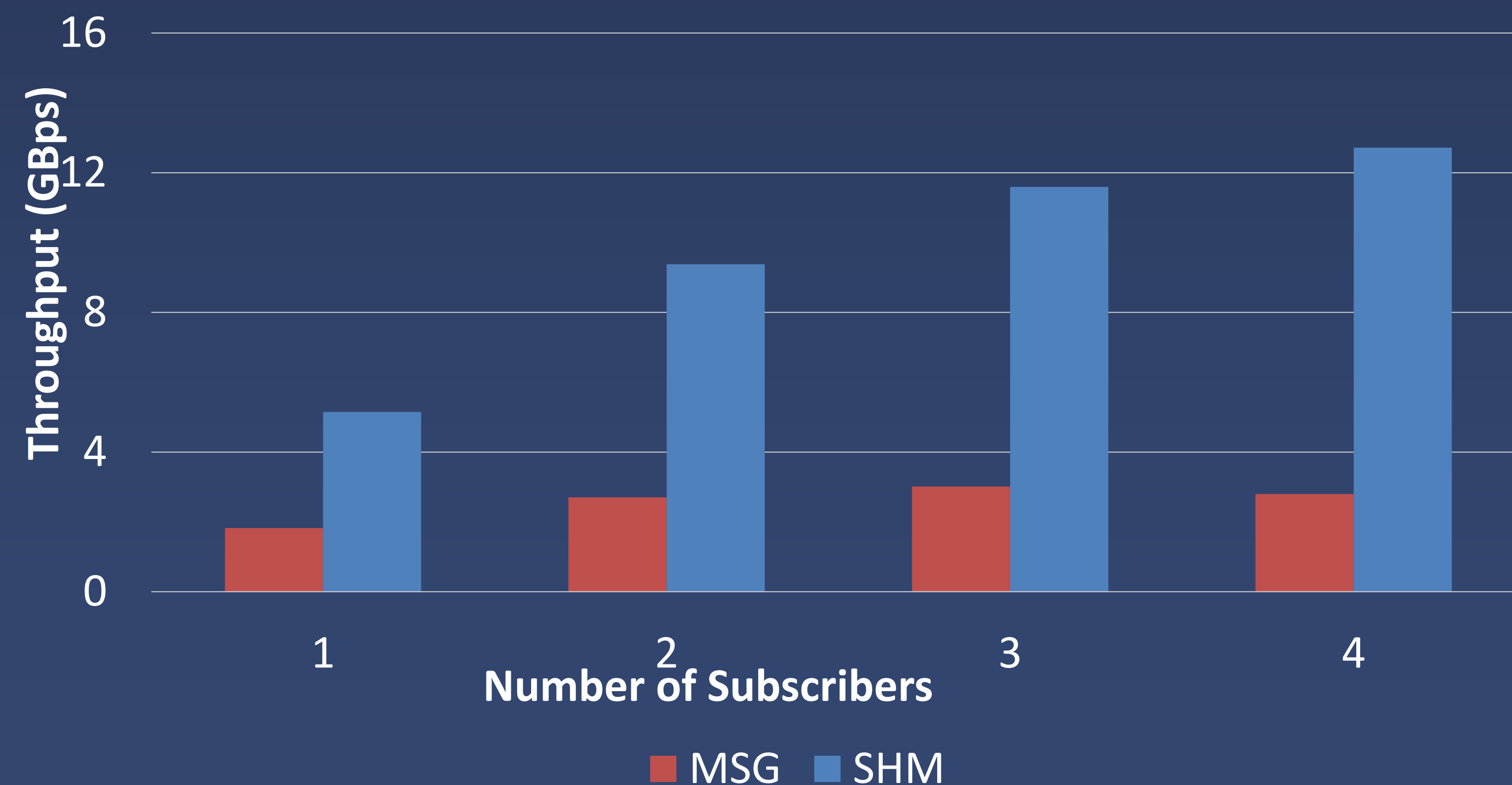




# 通信性能优化——效果

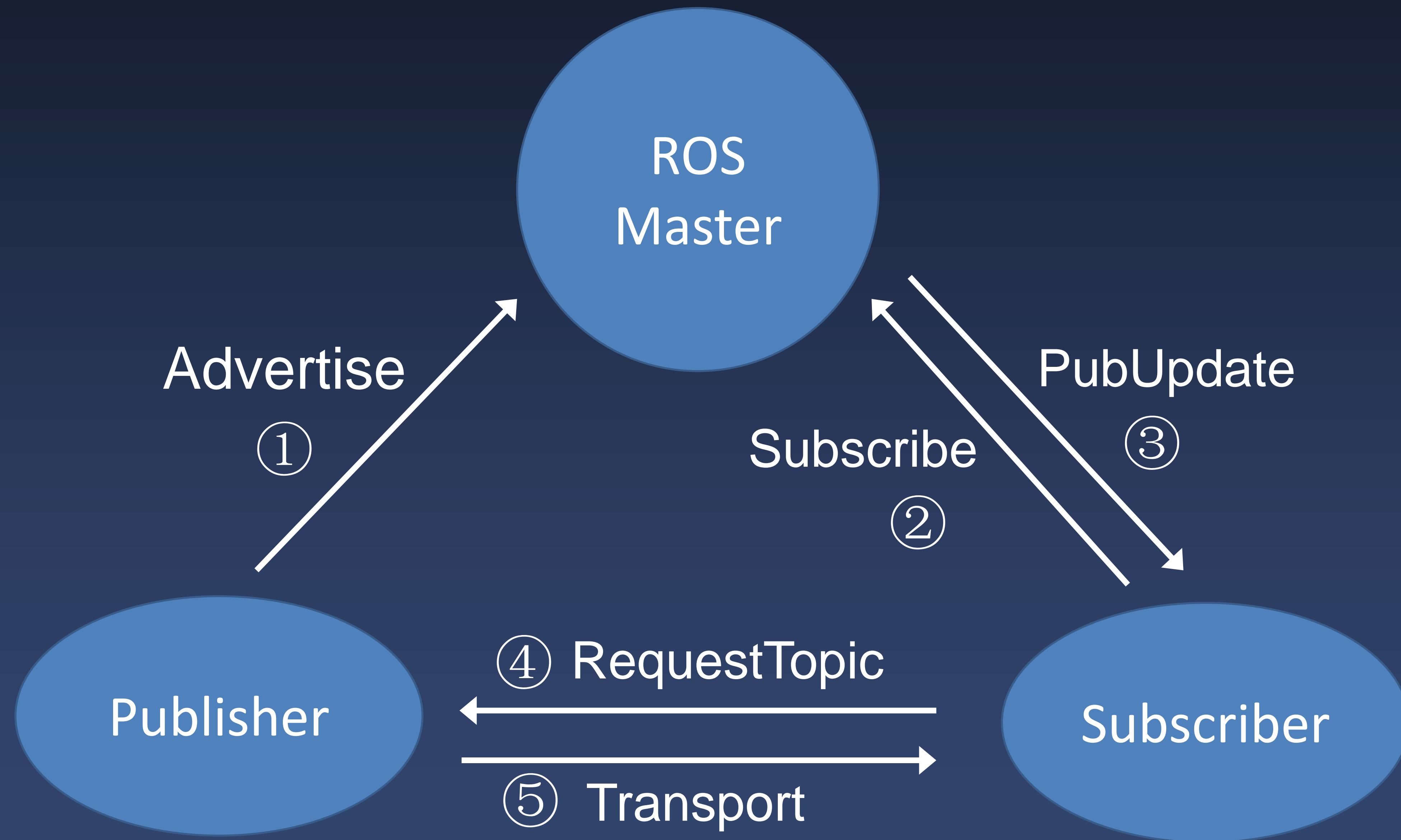
引入共享内存(Shared Memory) , 避免数据复制 :

- 消息通信时延降低约1-2倍
- 测试1:1吞吐均值可达5.5GB/s , 1:4吞吐均值可达12GB/s
- CPU资源占用率在共享内存模式下约降低30%



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## ROS以Master为中心构建hybrid p2p拓扑网络

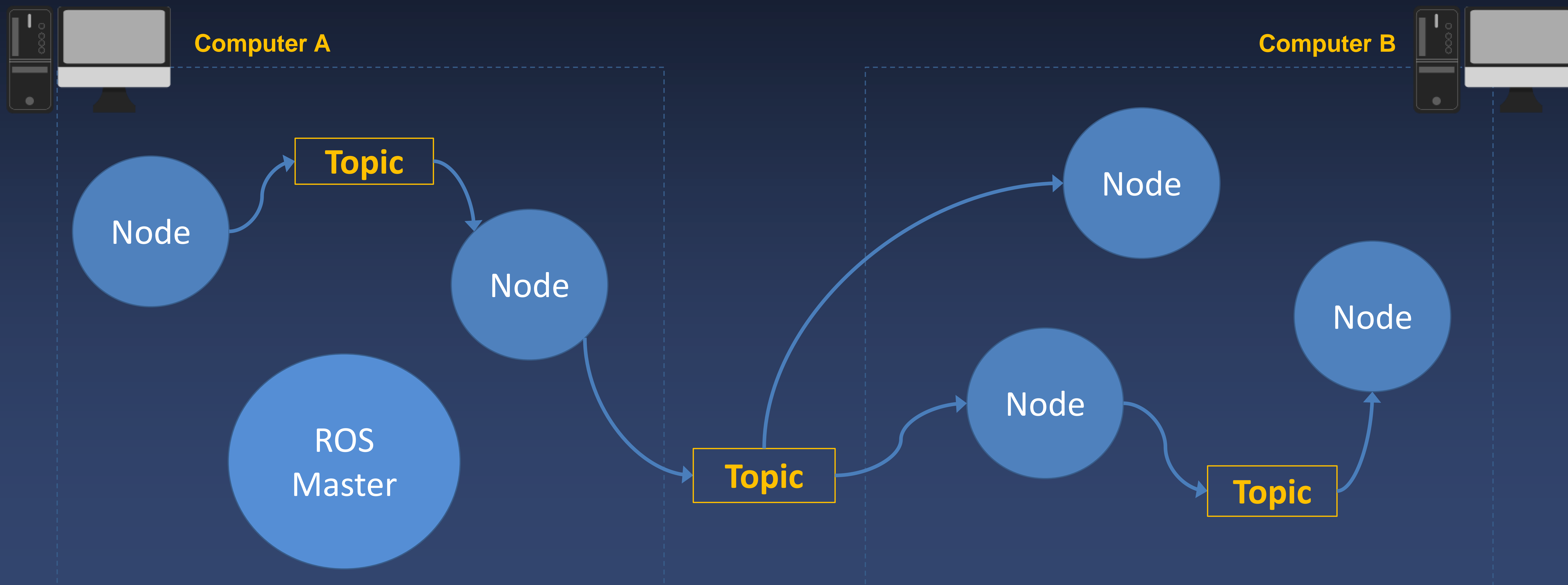


- 优势：
  - 节点容错性强
  - 不同语言模块隔离
  - 模块开发低耦合
- 缺点：
  - 过度依赖Master单点
  - 缺乏异常恢复机制

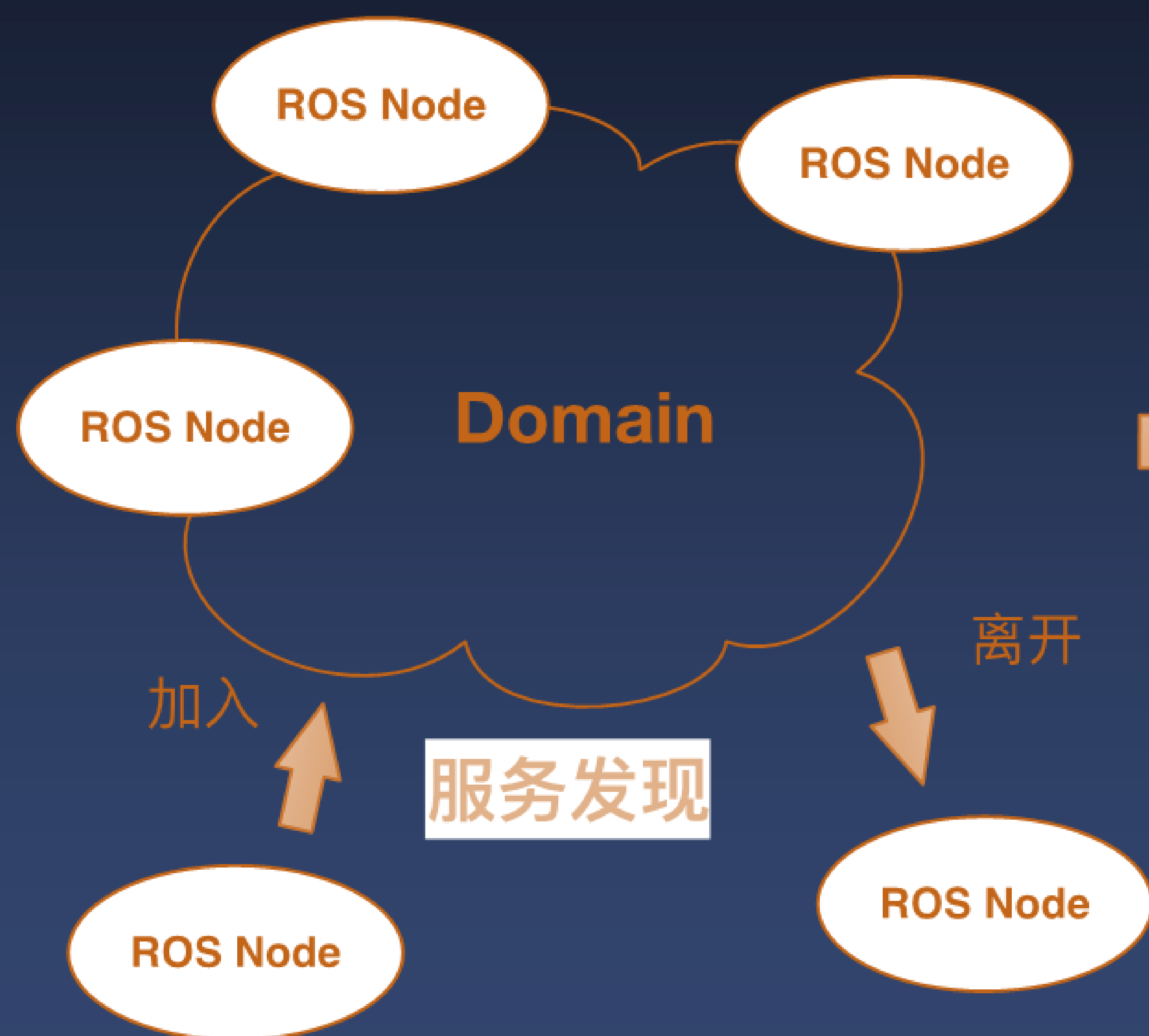
ROS节点建立连接的过程示例



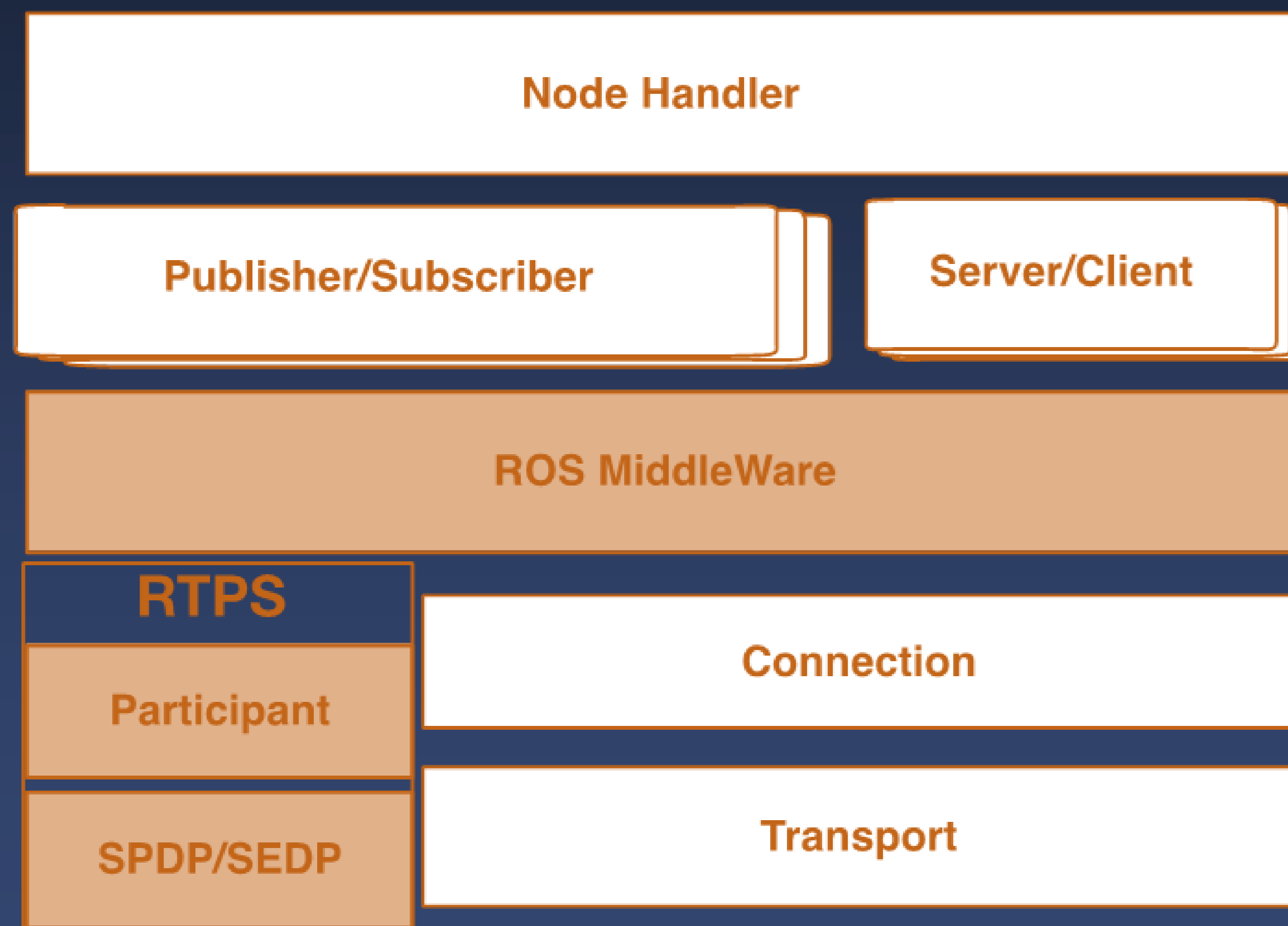
Master作为拓扑网络的中心，一旦异常将影响整个网络



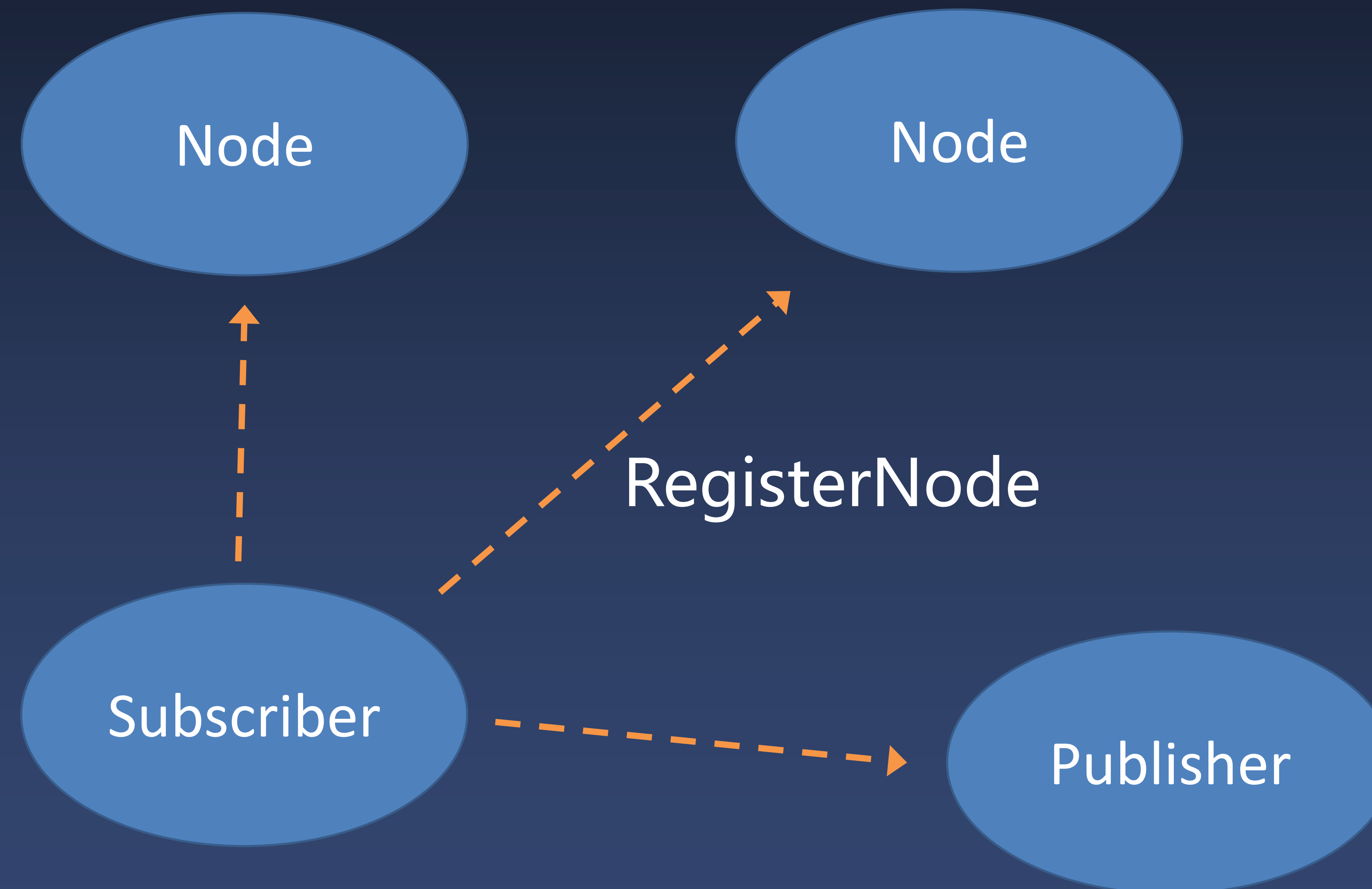
## 使用RTPS服务发现协议实现完全的P2P网络拓扑



### ROS Node



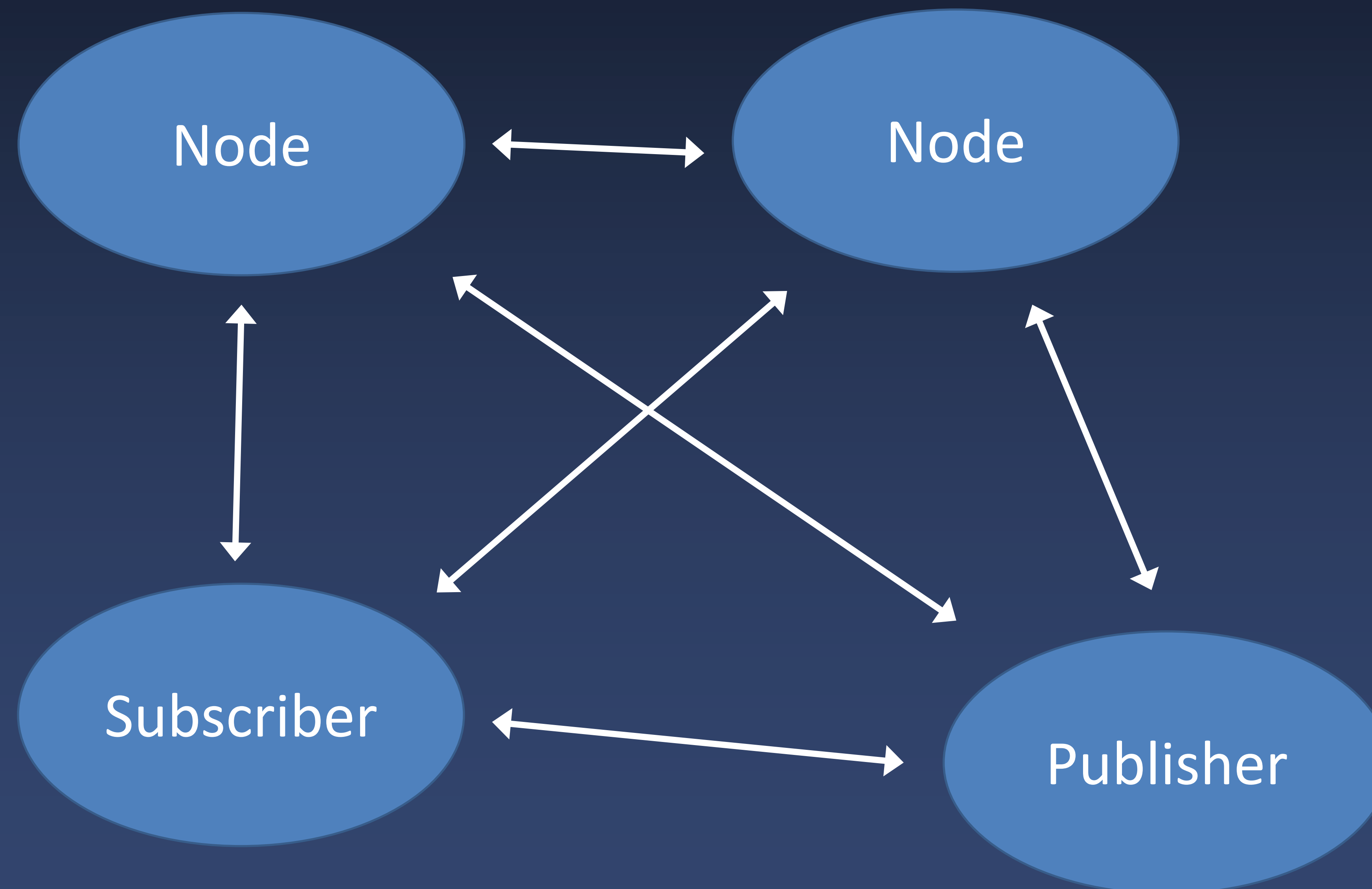
## 使用RTPS服务发现协议实现完全的P2P网络拓扑



① Sub节点启动，通过组播向网络注册

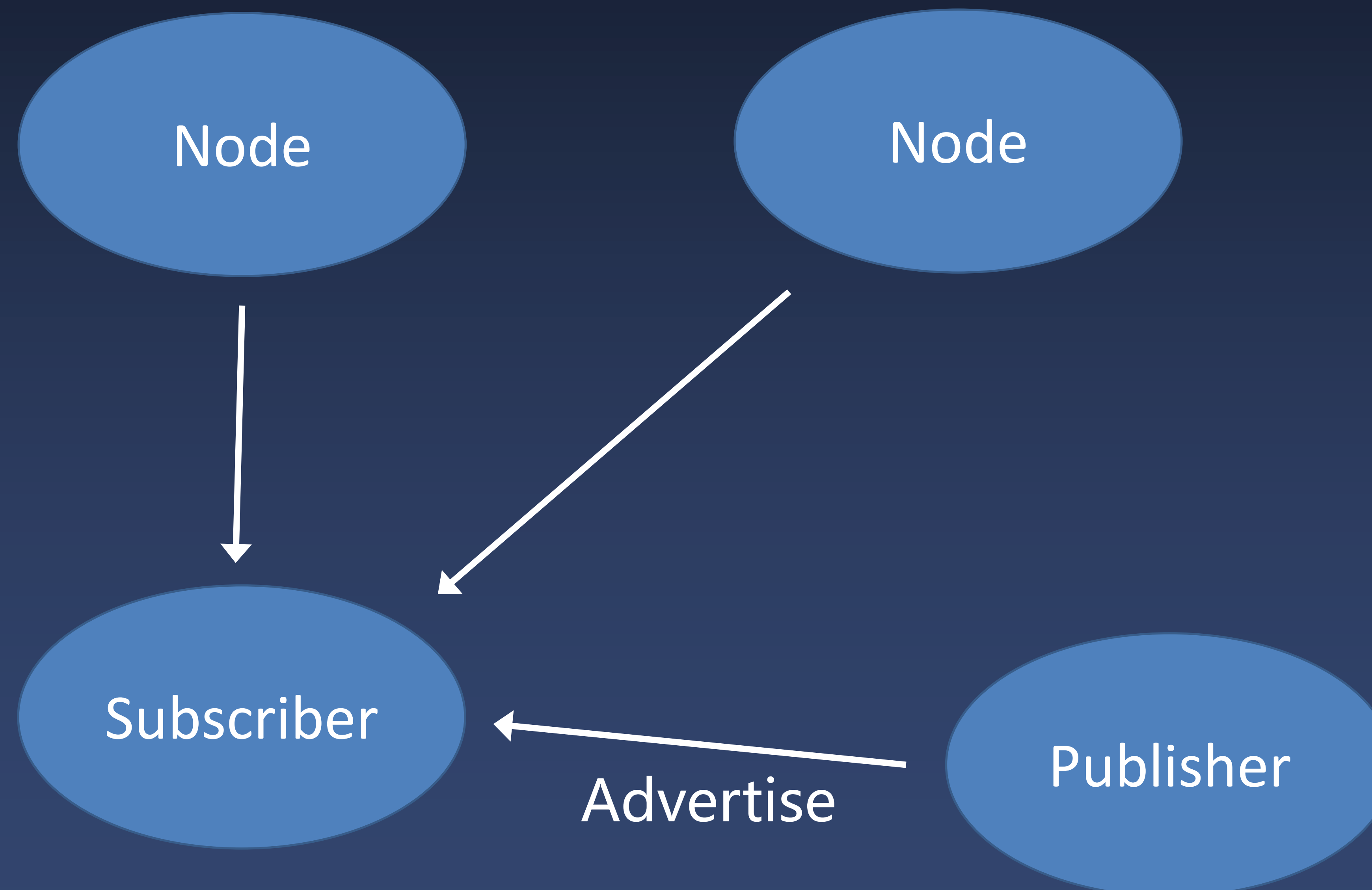


## 使用RTPS服务发现协议实现完全的P2P网络拓扑



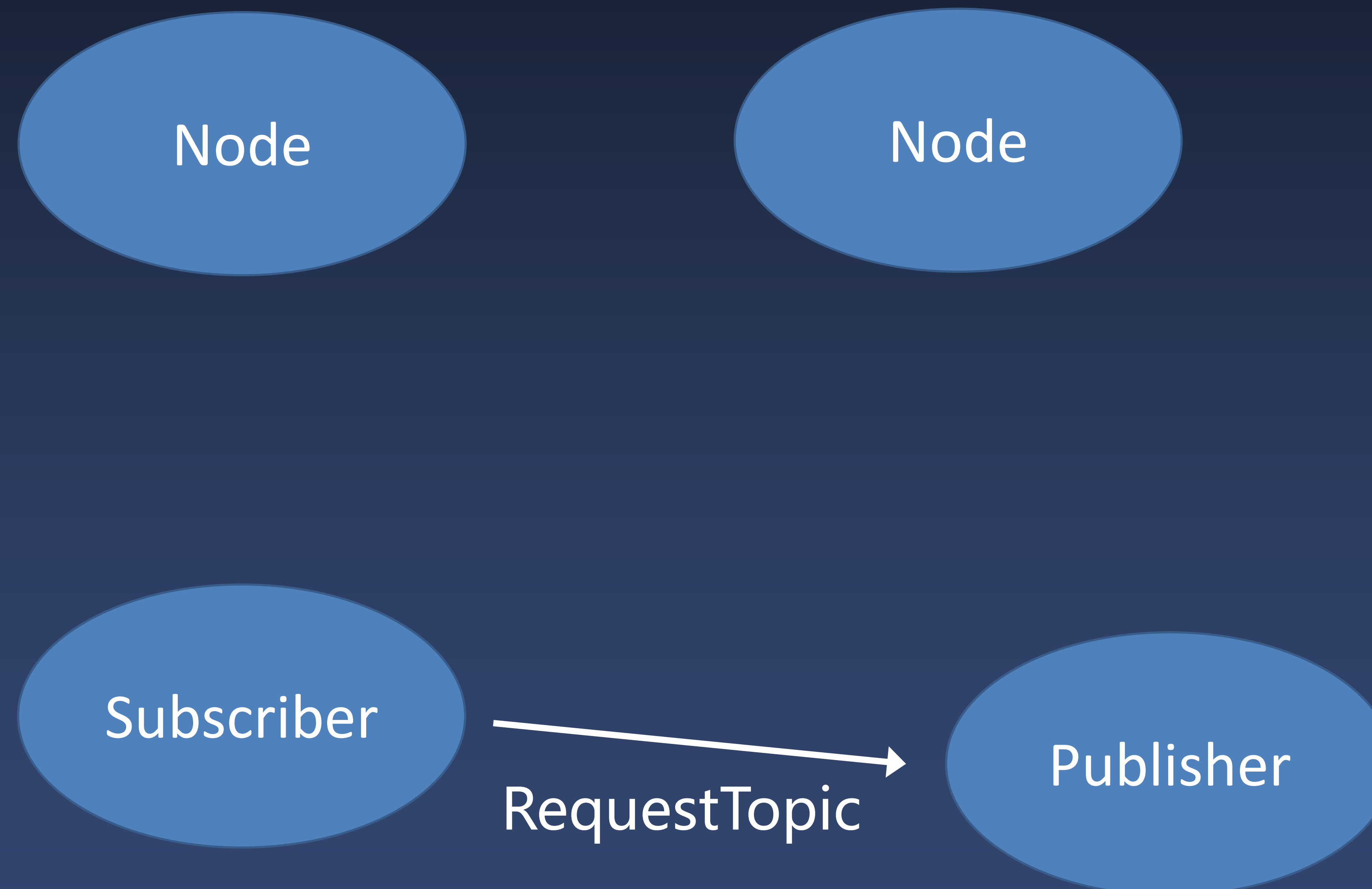
② 通过节点发现，两两建立unicast

## 使用RTPS服务发现协议实现完全的P2P网络拓扑



③ 向新加入的节点发送历史拓扑消息

## 使用RTPS服务发现协议实现完全的P2P网络拓扑

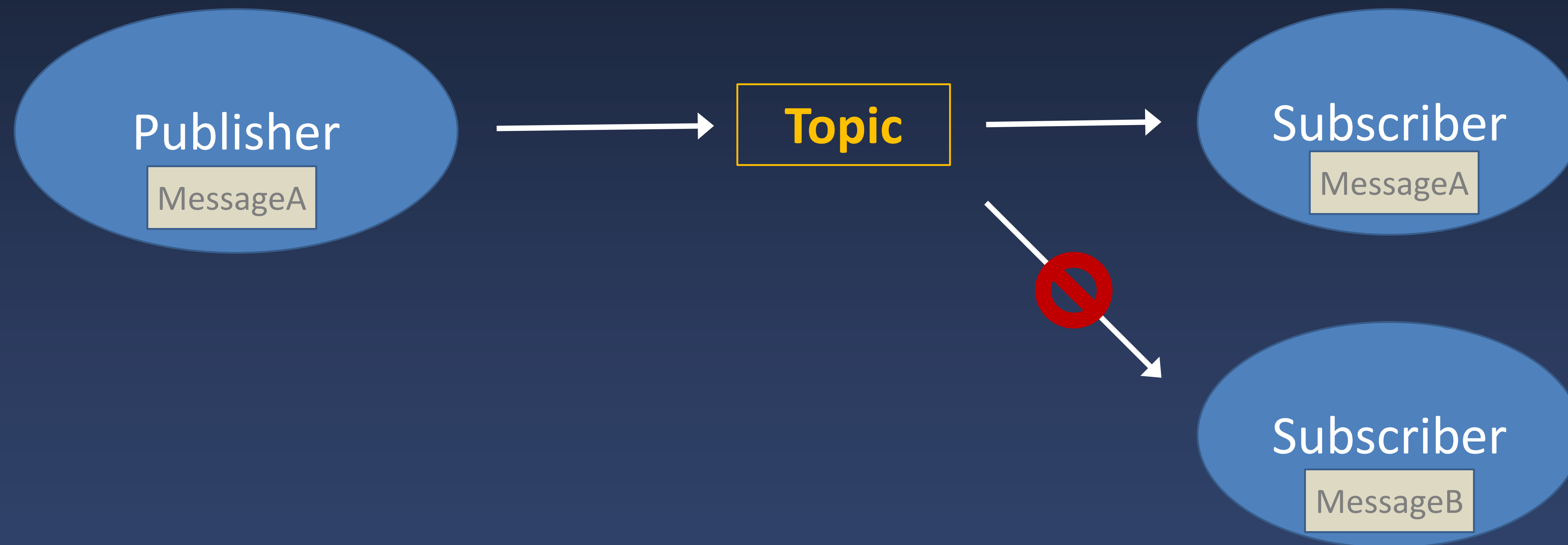


④ 收发双发建立连接，开始通信



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## Message是ROS中描述软件组件接口的语言

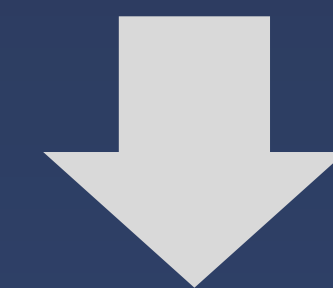


## ROS使用msg描述文件定义模块间的消息接口

- 数据结构定义
- 消息接口抽象描述文件
- 对应语言接口代码生成
  - C++ , Python...
- 基础message定义
  - Sensor\_msgs
  - Navigation\_msgs
  - Geomertry\_msgs

My\_package/ msg /example.msg

```
string field1
int8 field2
bool field3
Other_pkf_msg/custom field4
```



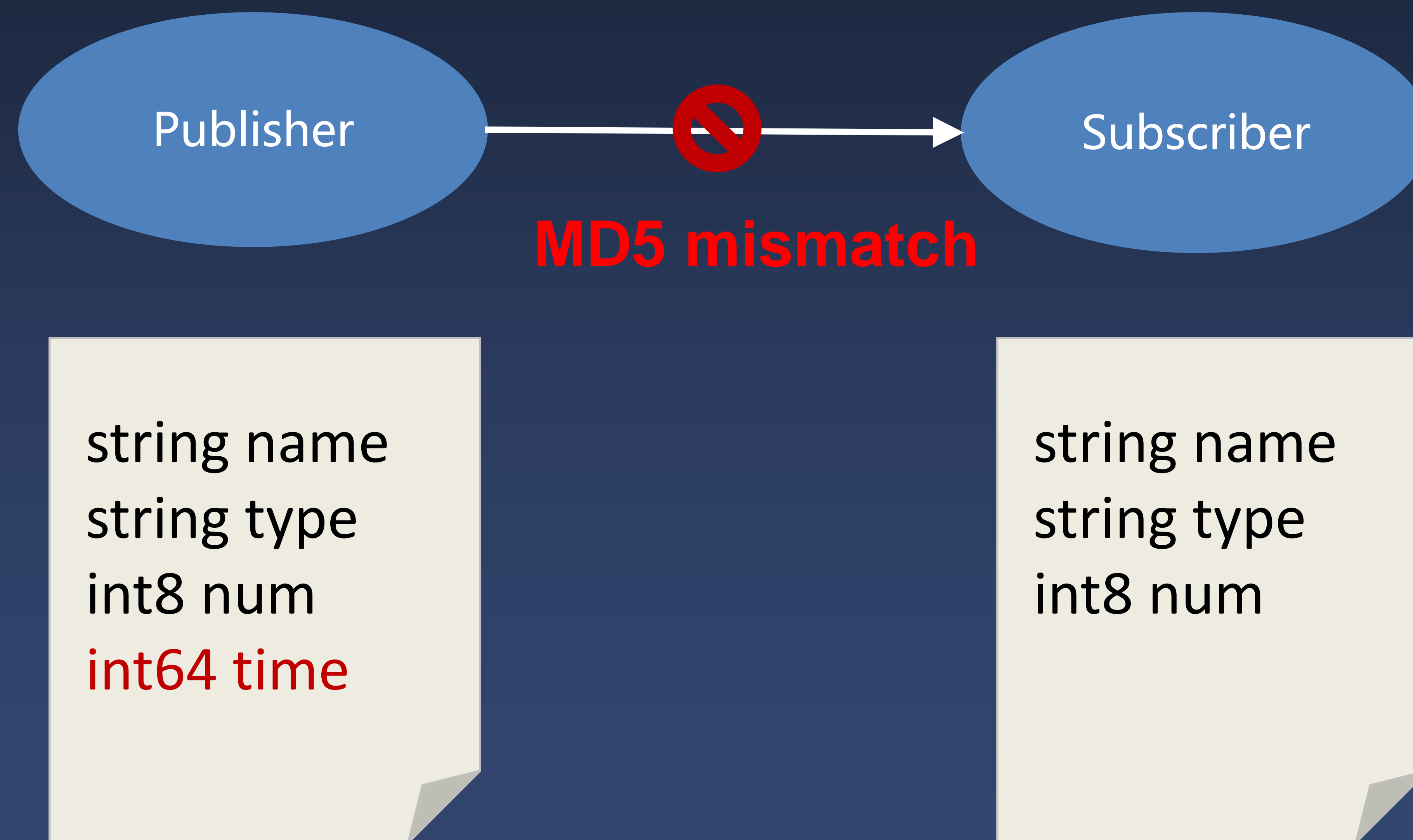
.h

.py

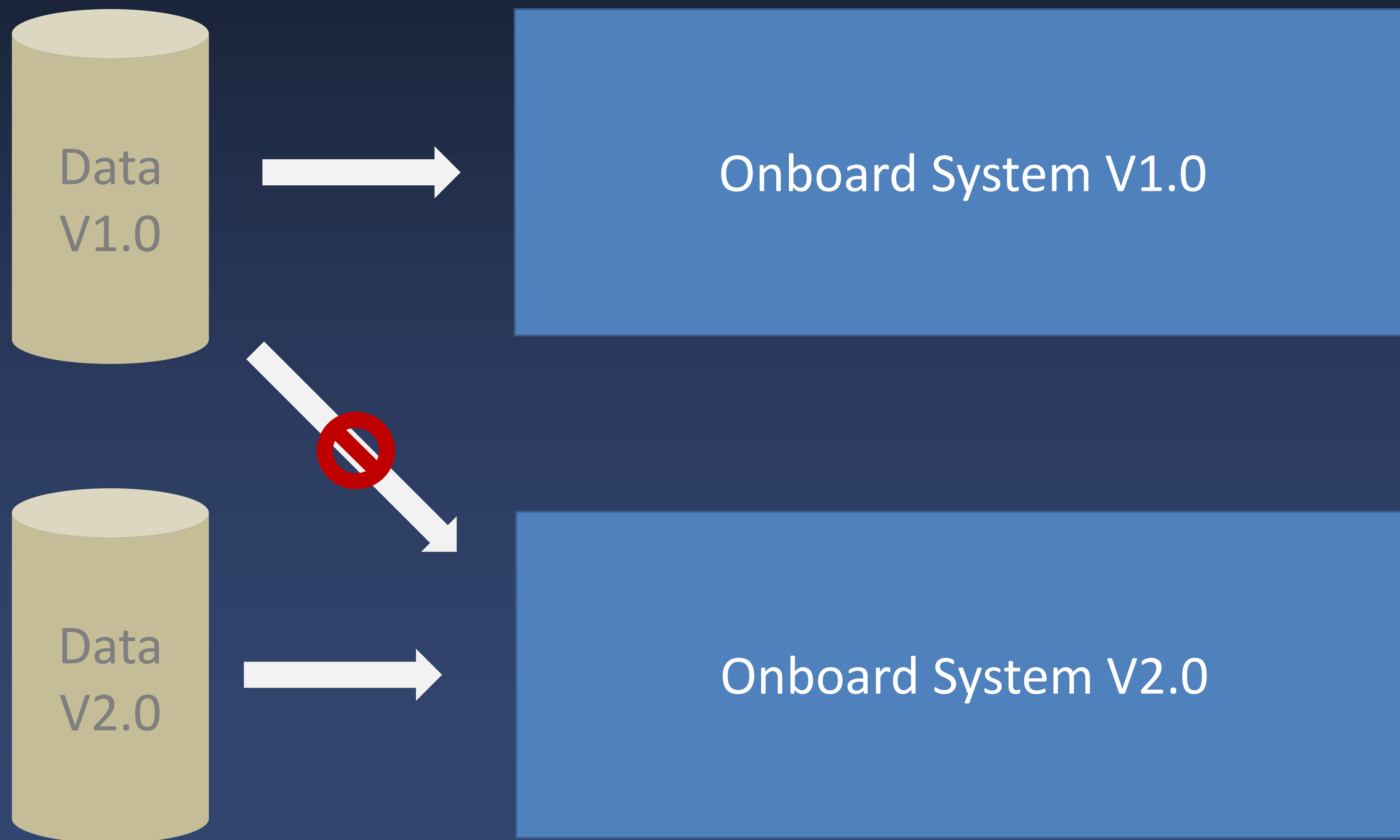
.java



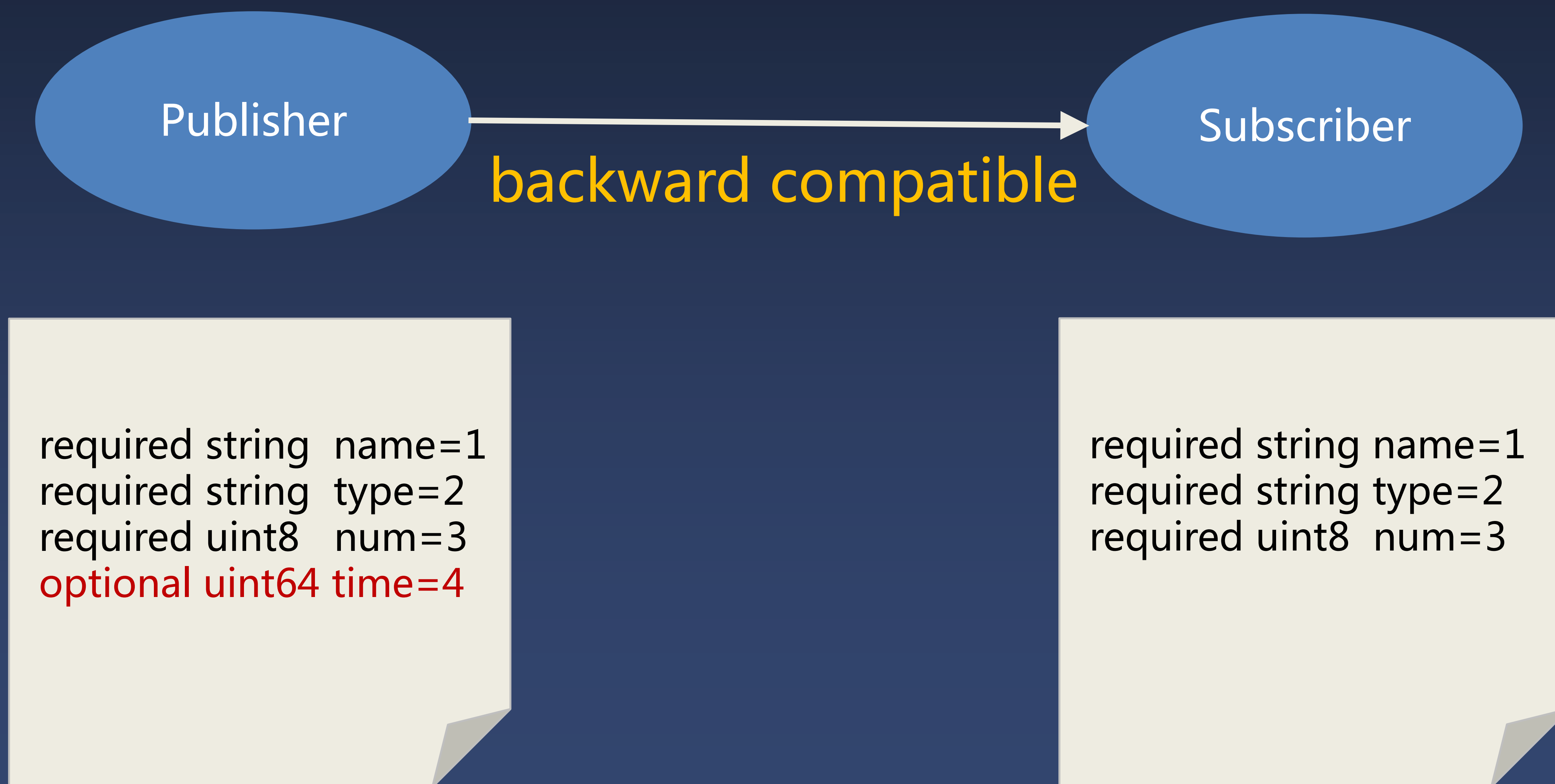
接口升级后，不同版本的模块难以兼容



接口升级后，历史数据也面临着无法使用的问题



protobuf能够很好地支持向后兼容





# 原生 ROS

- ```
166 set(PROTO_CONTROL_DIR ${CMAKE_CURRENT_SOURCE_DIR}/proto)
167 message("WORK_ROOT: " ${WORK_ROOT})
168
169 FILE(GLOB PROTO_FILES_COMMON "${PROTO_CONTROL_DIR}/*.proto")
170 message("PROTO_FILES_COMMON: " ${PROTO_FILES_COMMON})
171 PROTOBUF_GENERATE_CPP(PROTO_SRCS PROTO_HDRS ${PROTO_FILES_COMMON})
```

- ```
56     std_msgs::String ros_msg;
57     pb.SerializeToString(&ros_msg.data);
58     g_pad_msg_pub.publish(ros_msg);
```

- ```
-> % rostopic echo /sensor/gnss/rtk obs
00r0A0009 {H00E<C"[00000]g000009wA)v>û000A00900000E,C[00000]00!0wUA)GLj40A009`q000E@C"[
00sA)*0"T0[0A0090000EDCR[00000]0000
0A009Hl4@E[R[00000]00000000000MTA)E0)*000A0090000@ELC"[00000]0000MTA)60Fo9A0090100GEDCR[00000]
m0030wA)*0Sw00A0093000E@C"[00000-00wA)P7P000A0090000@E CR[00000]00000000000CUA)d0-0x0A009
0rA)35dI0A009000-0EHC[00000000000rA)8@0Z30A009000w0E4CR[00000]00000000000A)0
680GA009000E4C[00000]00000A)Ah00#0A009s_0E CR[00000]00000000000SA)0>0)C00A009@w000ELC[00000]Z000
```



```
19 add_proto_files(
20     DIRECTORY proto
21     FILES chatter.proto
22 )
```

- ```
18     pb_msgs::ShortMessage pb_msg;
19     ros::Time now = ros::Time::now();
20     pb_msg.mutable_stamp()->set_sec(now.sec);
21     pb_msg.mutable_stamp()->set_nsec(now.nsec);
22     std::stringstream ss;
23     ss << "Hello world " << count;
24     pb_msg.set_content(ss.str());
25
26     ROS_INFO("%s", pb_msg.content().c_str());
27     pb_chatter_pub.publish(pb_msg);
```

- ```
-> % rostopic echo /sensor/gnss/rtk obs
sat_obs { h stream.h src/car_ros_drivers/gnss/include/gnss
  sat_prn: 5
  sat_sys: BDS_SYS
  band_obs_num: 2
  band_obs { xlog.conf install/share/gnss_driver/conf
    band_id: BDS_B1
    frequency_value: 0
```



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# 如何获取Apollo

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## Apollo开放平台

<https://apollo.auto/>

## Github代码库

<https://github.com/ApolloAuto/apollo>

## 百度AI开放平台

<https://ai.baidu.com>

## 1. 安装docker


```
bash docker/scripts/install_docker.sh
# logout and login to make sure to run docker command without sudo
docker ps # to verify docker works without sudo
bash docker/scripts/dev_start.sh
bash docker/scripts/dev_into.sh
```

## 2. 编译Apollo

```
bash apollo.sh build
```

## 3. 启动Apollo

```
# start Human Machine Interface(HMI)
bash scripts/hmi.sh
```



### Quick Start

Before recording, you need to setup the system.

Quick Record: [New](#)

[Setup](#) [Start](#) [Stop](#)

Quick Play:

[Setup](#) [Start](#) [Stop](#)

### Debug

| Modules            |                          |
|--------------------|--------------------------|
| GPS Driver         | <input type="checkbox"/> |
| Control            | <input type="checkbox"/> |
| CAN Bus            | <input type="checkbox"/> |
| Localization       | <input type="checkbox"/> |
| Dreamview          | <input type="checkbox"/> |
| Apollo Data Record | <input type="checkbox"/> |

[Reset All](#) [Dreamview](#)

### Hardware

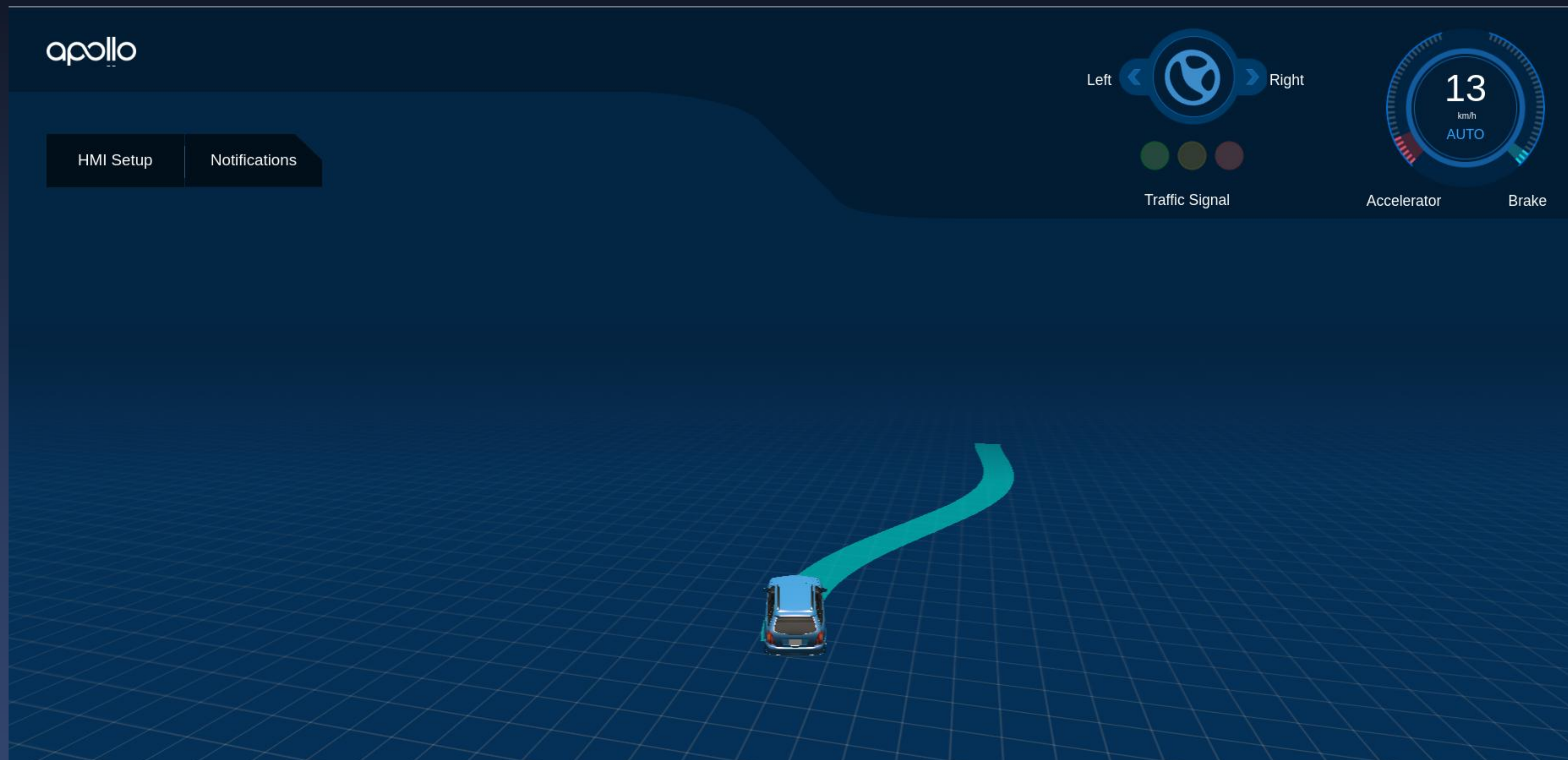
|     |                       |
|-----|-----------------------|
| GPS | <a href="#">Check</a> |
| CAN | <a href="#">Check</a> |







# 回放数据重现场景



```
# in a different terminal, in the apollo directory
bash docker/scripts/dev_into.sh # jump into the docker container
roslaunch apollo_hmi apollo_hmi.launch
```

ApolloAuto / apollo

Unwatch436

Unstar4,953

Fork901

- Code
- Issues35
- Pull requests0
- Projects0
- Wiki
- Settings
- Insights

Branch: master

apollo / docs / quickstart /

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History

AllenLyu committed with Jinghao Miao Added quickstart in Chinese

1 Latest commit cb59cd7 9 days ago

..

|                                                  |                                |             |
|--------------------------------------------------|--------------------------------|-------------|
| images                                           | Apollo 1.0.0 release           | 17 days ago |
| apollo_1_0_hardware_system_installation_guide.md | Fix kernel installation steps. | 14 days ago |
| apollo_1_0_quick_start.md                        | fixed typos                    | 16 days ago |
| apollo_1_0_quick_start_cn.md                     | Added quickstart in Chinese    | 8 days ago  |
| apollo_1_0_quick_start_developer.md              | Fix kernel installation steps. | 14 days ago |



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History

 **Capri2014** committed with **startcode** Update how\_to\_tune\_control\_parameters.md

Latest commit 060e615 9 days ago

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|                                                                                                                                              |                                          |             |
|----------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------|-------------|
|  <a href="#">how_to_add_a_gps_receiver.md</a>               | fixed typos                              | 16 days ago |
|  <a href="#">how_to_add_a_new_can_card.md</a>               | Apollo 1.0.0 release                     | 17 days ago |
|  <a href="#">how_to_add_a_new_control_algorithm.md</a>      | Apollo 1.0.0 release                     | 17 days ago |
|  <a href="#">how_to_add_a_new_vehicle.md</a>                | fixed typos                              | 16 days ago |
|  <a href="#">how_to_add_an_external_dependency.md</a>       | Apollo 1.0.0 release                     | 17 days ago |
|  <a href="#">how_to_build_and_release.md</a>              | fixed typos                              | 16 days ago |
|  <a href="#">how_to_debug_dreamview_start_problem.md</a>  | Apollo 1.0.0 release                     | 17 days ago |
|  <a href="#">how_to_document_code.md</a>                  | Apollo 1.0.0 release                     | 17 days ago |
|  <a href="#">how_to_save_load_docker_image_locally.md</a> | Apollo 1.0.0 release                     | 17 days ago |
|  <a href="#">how_to_style_check_to_one_dir.md</a>         | Apollo 1.0.0 release                     | 17 days ago |
|  <a href="#">how_to_troubleshoot_esdcan.md</a>            | Apollo 1.0.0 release                     | 17 days ago |
|  <a href="#">how_to_tune_control_parameters.md</a>        | Update how_to_tune_control_parameters.md | 9 days ago  |
|  <a href="#">how_to_update_vehicle_calibration.md</a>     | Apollo 1.0.0 release                     | 17 days ago |



谢谢