

Cosmos - RPC通信SDK使用说明

该文档主要介绍RPC实现及其使用案例。

SDK介绍

文件

PipeClient 项目

原理

技术架构：C++实现，导出C风格接口进行接入。以命名管道方式实现进程通信。SDK对外接口均进行异常捕捉保障稳定性。Windows平台下，所有能导入C库调用导出接口的架构终端均可接入（如主流C/C++，C#，Python，Java，Rust，Go等，后续以C++，C#举例说明，其他在此不做介绍）

管道原理：该SDK以命名管道方式实现进程通信。SDK作为管道客户端，以服务端（Cosmos）给定的管道名称基于重叠I/O方式向服务端连接管道，以实现管道双向读写通信。

SDK原理：由C++代码实现，主要包括客户端管道类（PipeClient）和对外导出接口（注册回调接口、管道初始化接口、同步发送消息接口、通知消息接口、订阅接口、推送接口和内存释放接口）。业务层通过注册回调接口可向SDK注册响应消息及内存释放接口；通过管道初始化接口可启动管道客户端向服务端建立管道通信；通过导出的消息接口借用SDK向管道服务端发送对应消息处理业务。

业务协议（SDK接口调用协议）：

1) 请求消息体

```
struct RpcRequest
{
    std::string id;           // 请求唯一id
    std::string method;       // 请求方法
    json param;              // 请求参数 (json对象)
};
```

2) 应答消息体

```
struct RpcResponse
{
    std::string id;           // 应答唯一id
    int code = 0;             // code = 0 表示业务返回成功, code != 0 表示业务返回错误,
    // 业务按需定义错误编码
    json error;               // 应答错误时返回业务报错内容
    json result;              // 应答成功时返回业务数据
};
```

3) 推送消息体

```

struct RpcPush
{
    std::string topic;           // 推送业务类型
    json param;                // 推送数据
};

```

通信协议：

1) 消息类型：INVK - 同步消息；NOTF - 通知消息；SUBS - 订阅消息；PUSH - 推送消息

2) 消息格式：

协议格式："方法 (4位) | data长度 (8位) | 预留符 (12位) | uuid (36位, 包含-) | 数据"

示例："INVK|00000013|000000000000|d736df35-3d89-4cc8-8520-d6789cc49bd3|msgfromserver"

3) 消息处理：

a. 先读取消息头（固定为64字节）：按协议格式解析出 方法，长度，预留符，uuid

b. 再读取消息体（按长度）：根据 方法 将消息体 分发给对应的注册回调的消息处理接口

INVK --> OnInvoke; NOTF --> OnNotify; SUBS --> OnSubscribe; PUSH --> OnPush (回调见后续注册回调接口说明)

4) 数据类型：接口均以 char* 方式传入

5) 数据量：单消息支持千万字节长度（理论最大长度：99999999字节，注：需考虑业务实际，如系统缓冲区足够）

6) 时延：采用重叠I/O方式支持双向读写，目前延时受系统CPU资源调度、系统API因素影响，在ms级别。（注：读取数据后的处理受业务耗时影响）

导出接口

1. 注册回调接口

```

typedef void*(_cdecl*OnInvoke)(void* _in, int size);
typedef void(_cdecl* OnNotify)(void* _in, int size);
typedef void(_cdecl* OnSubscribe)(void* _in, int size);
typedef void(_cdecl* OnPush)(void* _in, int size);
typedef void(_cdecl* OnFreeVoidPtr)(void* _in);
typedef void(_cdecl InvokeCallback)(RET_CALL, void*, int);

void Register(OnInvoke invoke, OnNotify notify, OnSubscribe subscribe, OnPush
push, OnFreeVoidPtr FreeVoidPtr);

```

功能：业务层向SDK注册消息处理的回调函数

返回结果：无

参数说明：

OnInvoke -- 表示业务层响应SDK收到的 INVK 消息，即处理对方进程发送的 INVK 事件，该事件处理结果由SDK自动返回给发送方进行后续处理

OnNotify -- 表示业务层响应SDK收到的 NOTF 消息，即处理对方进程发送的 NOTF 事件

OnSubscribe -- 表示业务层响应SDK收到的 SUBS 消息，即处理对方进程发送的 SUBS 事件

OnPush -- 表示业务层响应SDK收到的 PUSH 消息，即处理对方进程发送的 PUSH 事件

OnFreeVoidPtr -- 表示业务层释放分配的内存

InvokeCallback -- 表示业务层异步调用Invoke时向SDK注册的回调函数，以处理invoke返回数据
(参数2) 的业务逻辑

Register -- 函数注册入口

2. 管道初始化接口

```
bool InitClient(const char* in_msg, int size, const char* log_path, int
log_path_size, int protocol_level = 1, double del_log_cycle = 3.0, bool
bdetaillog = false);
bool InitClientForC(const char* in_msg, int size, const char* log_path, int
log_path_size, double del_log_cycle = 3.0, bool bdetaillog = false); // 为适配旧版
Testwpf新增接口，该接口仅支持结构体协议，故仅能为C/C++使用
```

功能：业务层启动管道客户端并向服务端建立连接

返回结果：连接成功 --> 成功； 初始化失败 --> 失败

参数说明：

in_msg -- 管道名称（由服务端生成），用于客户端连接

size -- 管道名称长度

log_path -- SDK通信日志记录文件完整路径（含文件名）

log_path_size -- log_path长度

protocol_level -- 业务协议级别（1 -- 结构体协议（C++使用），2 -- 字符串协议（C#及其他使用））

del_log_cycle -- 保存日志周期（单位：天数，默认3天）

bdetaillog -- 是否记录详细日志标志（true：记录详细日志；false：记录简易日志）

3. Invoke发送消息接口

```
enum class RET_CALL{
    Exception = -3, // 抛出异常
    Sendfail = -2, // 发送失败
    Timeout = -1, // 处理超时
    Pipenull = 0, // 管道实例销毁
    Ok = 1 // 处理成功
};

RET_CALL Invoke(void* _in, void** _out, int* _out_size, int timeout = 30000);
void InvokeAsync(void* _in, InvokeCallback callback, int timeout = 30000);
```

功能：业务层通过SDK向管道服务端发送同步(Invoke) 或 异步(InvokeAsync) INVK 消息，并得到服务端
处理 INVK 消息后返回给业务层的结果

返回结果：见 RET_CALL 枚举说明

参数说明：

_in -- 业务层需要通过SDK发送给服务端的消息体（业务数据）

_out -- 服务端处理 INVK 消息后返回给业务层的结果 (业务数据)
_out_size -- _out 长度 (主要在 字符串协议 时使用, 结构体协议时为0)
timeout -- 设定的超时时间 (单位: 毫秒, 默认值: 30000)
callback-- 回调函数 (见 InvokeCallback, 用以处理返回数据)

4. 通知消息接口

```
RET_CALL Notify(void* _in);
```

功能：业务层通过SDK向管道服务端发送 NOTF 通知消息，用于普通消息发送，且服务端业务层无返回业务数据场景

返回结果：见 RET_CALL 枚举说明

参数说明：

_in-- 业务层需要通过SDK发送给服务端的消息体 (业务数据)

5. 订阅消息接口

```
RET_CALL Subscribe(void* _in);
```

功能：业务层通过SDK向管道服务端发送 SUBS 订阅消息，用于向服务端业务层订阅数据场景（注订阅管理及协议由业务双方实现，SDK仅做通信）

返回结果：见 RET_CALL 枚举说明

参数说明：

_in-- 业务层需要通过SDK发送给服务端的消息体 (业务数据)

6. 推送消息接口

```
RET_CALL Push(void* _in);
```

功能：业务层通过SDK向管道服务端发送 PUSH 推送消息

返回结果：见 RET_CALL 枚举说明

参数说明：

_in-- 业务层需要通过SDK发送给服务端的消息体 (业务数据)

7. 内存释放接口

```
void FreeRpcAllocMemory(void* _in);
```

功能：业务层释放SDK分配的内存

返回结果：无

参数说明：

_in-- 需要释放的内存指针

8. 创建请求体接口

```
void* CreateRpcRequest(const char* id, const char* method, const char* param);
```

功能：业务层调用SDK接口创建请求体（返回的void*由SDK分配内存，业务层需要自己调用FreeRpcAllocMemory释放）

返回结果：请求体

参数说明：

id-- 请求id

method -- 请求方法

param -- 请求参数

9. 创建推送提接口

```
void* CreateRpcPush(const char* topic, const char* param);
```

功能：业务层调用SDK接口创建推送体（返回的void*由SDK分配内存，业务层需要自己调用FreeRpcAllocMemory释放）

返回结果：推送体

参数说明：

topic -- 推送业务类型

param-- 推送数据

实现

SDK具体实现，见已提供的源码（RpcClint 中的 PipeClient 项目）

SDK使用案例

基础流程

- 1) 服务端：服务端业务层启动服务端管道（自动启动客户端进程）
- 2) 客户端：客户端进程被启动；解析命令参数获取管道名称（固定为第一个参数）；注册回调Register；启动客户端管道InitClient
- 3) 双方收发消息

服务端（Cosmos）

以 Cosmos.App.Hithink.WpfProcessDemo 为例（见：
*/Cosmos.App.Hithink.WpfProcessDemo/WpfProcessDemoGui.cs 文件）

服务端注意点：

- a. 适配屏幕缩放比
- b. 设置标志防止服务端管道多开
- c. 在业务组件第一次启动时启动管道，在业务组件退出关闭时释放组件

d. 启动管道时传入 父窗口句柄、窗口尺寸，以便客户端进程设置父子关系和适配尺寸位置

e. 窗口尺寸变化时，通知客户端进程尺寸变化消息以自动适应

部分代码介绍如下（注：主要介绍涉及到管道SDK通信相关）：

1) 声明管道变量

```
// 服务端进程通信器
public ICosmosRpcManager rpcManager { get; set; }
```

2) 构造初始化

```
public WpfProcessDemoGui()
{
    _wfh = new WpfCosmosHwndHost();
    _wfh.Margin = new Thickness(0, 0, 0, 0);
    // 设置大小改变事件
    _wfh.SizeChanged += _wfh_SizeChanged;
    SystemParameters.StaticPropertyChanged += SystemParameters_StaticPropertyChanged;

    // 设置窗口加载成功事件
    _wfh.Loaded += _wfh_Loaded;
    Content = _wfh;
}

WpfCosmosHwndHost _wfh { get; set; }
```

3) 启动/释放管道

```
// 窗口加载
private void _wfh_Loaded(object sender, RoutedEventArgs e)
{
    _logger?.Log(CosmosLogLevel.Information, "wfh_Loaded");

    // 窗口创建成功、可以启动进程通信服务
    StartRpcServer();
}

// 响应窗口尺寸变化
private void _wfh_SizeChanged(object sender, SizeChangedEventArgs e)
{
    ChangeProcessWindowSize();
}

// 响应屏幕缩放比例变化
private void SystemParameters_StaticPropertyChanged(object sender,
PropertyChangedEventArgs e)
{
    var currentDpi = VisualTreeHelper.GetDpi(this);
    _logger.Log(CosmosLogLevel.Information,
[SystemParameters_StaticPropertyChanged"]);
    if (currentDpi.DpiScaleX != _previousDpi.DpiScaleX)
    {
        _previousDpi = currentDpi;
        ChangeProcessWindowSize();
    }
}
```

```

        }

    }

    // 通知客户端进程更改窗口尺寸
    private void ChangeProcessWindowSize()
    {
        try
        {
            //切换到主线程获取窗口大小
            Dispatcher.InvokeAsync(() =>
            {
                //窗口发生变化、通知进程需要调整窗口大小
                //组装调整大小命令、进程按照该组装方式进行解析
                var graphics = VisualTreeHelper.GetDpi(this);
                ICosmosRpcRequest request = rpcManager?.CreateRpcRequest();
                request.id = Guid.NewGuid().ToString(); // 设置请求id
                request.method = "setsize"; // 设置请求方法
                request.param = new JObject // 设置请求参数
                {
                    ["width"] = _wfh.ActualWidth,
                    ["height"] = _wfh.ActualHeight,
                    ["dpiRatio"] = _dpiRatioFirst,
                    ["curscaling"] = graphics.DpiScaleX
                };

                g_mapRequest[request.id] = request; // 保存请求数据
                rpcManager?.NotifyAsync(request); // 向客户端进程发送Notify消息
            });
        }
        catch (Exception ex)
        {
            _logger?.Log(CosmosLogLevel.Error, $"调整窗口大小失败 {ex.Message}");
        }
    }

    // 组件彻底关闭时会调用到该方法
    public override async Task StopAsync(CancellationToken cancellationToken)
    {
        //组件关闭、释放进程通信资源
        ReleaseRpcMnager();
    }

    // 启动管道
    Private int ProcessId;
    public double _dpiRatioFirst = 1;
    private DpiScale _previousDpi;
    async void StartRpcServer()
    {
        try
        {
            // 1.通过接口创建进程通信管理器
            rpcManager =
_ContextInjection.ThisAppContext.GlobalContexts.EngineContext.BusinessRequest.CreateRpcManager();

            // 2、注册回调函数、响应对方进程的调用
            rpcManager.OnInvoke += HandleInvoke;
            rpcManager.OnPush += HandlePush;
        }
    }
}

```

```

        rpcManager.OnNotify += HandleNotify;
        rpcManager.OnSubscribe += HandleSubscribe;

        // 3. 获取进程所在路径
        var clientDir =
System.IO.Path.Combine(System.IO.Path.GetDirectoryName(System.IO.Path.GetDirectoryName(Path.GetDirectoryName(Assembly.GetExecutingAssembly().Location))), 
@"content\dependents\Testwpf.exe");

        // 4. 手动获取当前WPF应用程序窗口句柄和真实窗口大小，组装命令行参数（用于客户端进程业务
设置父子窗口和适配尺寸）
        var hwnd = _wfh.Handle;
        var hwndGraphics = Graphics.FromHwnd(hwnd);
        double dpiRatio = hwndGraphics.DpiX / 96;
        var actualWidth = _wfh.ActualWidth * dpiRatio;
        var actualHeight = _wfh.ActualHeight * dpiRatio;
        string strCmd = $"{hwnd}|{(int)actualWidth}|{(int)actualHeight}";

        // 5. 启动进程通讯服务，并将当前父窗口的进程id和窗口大小通知对方进程、返回对方进程
id (_logger，传入后服务端管道会记录通信日志信息）
        ProcessId = rpcManager.StartServerWithProcessId(clientDir, strCmd,
_logger);
        if (ProcessId != 0)
        {
            // 创建成功，向cosmos引擎设置进程信息

            ContextInjection.ThisAppContext.GlobalContexts.EngineContext.BusinessRequest.Se
tProcessInfo(ProcessId, this);
        }
    }

    catch (Exception ex)
    {
        _logger?.Log(CosmosLogLevel.Error, $"StartRpcServer:{ex.ToString()}");
    }

    _logger?.Log(CosmosLogLevel.Information, "StartRpcServer");
}

// 释放管道资源
private async void ReleaseRpcMnager()
{
    try
    {
        // 组件关闭
        // 1. 向cosmos引擎取消注册的进程信息

        ContextInjection.ThisAppContext.GlobalContexts.EngineContext.BusinessRequest.Re
moveProcessInfo(ProcessId);

        // 2. 发送关闭通知给进程
        string sizeinfo = $"close|";
        await rpcManager?.NotifyAsync(sizeinfo);

    }
    catch (Exception ex)
    {
        _logger?.Log(CosmosLogLevel.Error, $"ReleaseRpcMnager:{ex.ToString()}");
    }
}

```

```
        _logger?.Log(CosmosLogLevel.Information, "ReleaseRpcManager");
    }
```

4) 消息发送及响应

```
// 发送进程消息和处理进程消息
async Task<string> QryAccount_InvokeAsync()
{
    // 异步查询账户信息
    ICosmosRpcRequest async_param = rpcManager?.CreateRpcRequest();
    async_param.id = Guid.NewGuid().ToString();
    async_param.method = "qry_account";
    async_param.param = new JObject
    {
        ["ID"] = "123456", // 查询账户123456的信息
    };

    g_mapRequest[async_param.id] = async_param;
    ICosmosRpcResponse async_ret = await rpcManager?.InvokeAsync(async_param,
    10000); // 10秒超时
    {

        // 处理返回结果 async_ret
        if (g_mapRequest.ContainsKey(async_ret.id))
        {
            // 找到了请求上下文
            if (async_ret.code == 0)
            {
                // 返回业务成功
                string async_method = g_mapRequest[async_ret.id].method;
                if (async_method == "qry_account")
                {
                    string ID = (string)async_ret.result["ID"];
                    if (g_mapActInfo.ContainsKey(ID))
                    {
                        g_mapActInfo[ID].Type = (int)async_ret.result["Type"];
                        g_mapActInfo[ID].Status =
                            (int)async_ret.result["Status"];
                    }
                }
            }
            else
            {
                // 返回业务报错
                // 按报错处理
            }
        }
    }

    return "OK";
}

private void HandlePush(ICosmosRpcPush data)
{
    // 处理SDK端发送Push消息
    string topic = data.topic;
    if (topic == "push_account")
```

```

{
    // 处理推送账户信息
    string strID = (string)data.param["ID"];
    if (g_mapActInfo.ContainsKey(strID))
    {
        g_mapActInfo[strID].Type = (int)data.param["Type"];
        g_mapActInfo[strID].Status = (int)data.param["Status"];
    }
}
}

private void HandleNotify(ICosmosRpcRequest data)
{
    // 处理SDK发送的Notify消息
    string method = data.method;
    if (method == "init_succ")
    {
        // 对方进程初始化完成，按需实现业务需求
        ChangeProcessWindowSize();
    }
    else if (method == "notf_sub")
    {
        // 对方初始化成功，可以向其发送通信，这里做如下业务操作
        // 1、订阅账户信息
        ICosmosRpcRequest sub = rpcManager?.CreateRpcRequest();
        sub.id = Guid.NewGuid().ToString();
        sub.method = "sub_account";
        sub.param = new JObject
        {
            ["ID"] = "123456" //订阅账户123456信息
        };

        g_mapRequest[sub.id] = sub;
        rpcManager?.SubscribeAsync(sub);

        // 2、查询账户信息（同步调用）
        ICosmosRpcRequest sync_param = rpcManager?.CreateRpcRequest();
        sync_param.id = Guid.NewGuid().ToString();
        sync_param.method = "qry_account";
        sync_param.param = new JObject
        {
            ["ID"] = "ALL" //查询所有账户信息
        };

        g_mapRequest[sync_param.id] = sync_param;
        ICosmosRpcResponse sync_ret = rpcManager.InvokeAsync(sync_param).Result;
        //默认30秒超时
        {
            // 处理返回结果 sync_ret
            if (g_mapRequest.ContainsKey(sync_ret.id))
            {
                // 找到了请求上下文
                if (sync_ret.code == 0)
                {
                    // 返回业务成功
                    string async_method = g_mapRequest[sync_ret.id].method;
                    if (async_method == "qry_account")
                    {

```

```

                JToken resultToken = sync_ret.result;

                // 反序列化 result 属性
                var deserializedAccounts =
JsonConvert.DeserializeObject<List<AccountInfo>>(resultToken.ToString());
                    foreach (var account in deserializedAccounts)
                    {
                        g_mapActInfo[account.ID] = account;
                    }
                }
            }
        else
        {
            // 返回业务报错
            // 按报错处理
        }
    }
}

// 3、查询账户信息（异步调用）
QryAccount_InvokeAsync();
}

private ICosmosRpcResponse HandleInvoke(ICosmosRpcRequest data)
{
    // 处理SDK发送的Invoke消息
    ICosmosRpcResponse resp = rpcManager.CreateRpcResponse();
    if (data.method == "requestTheme")
    {
        resp.code = 0;
        var theme =
_ContextInjection.ThisApplicationContext.GlobalContexts.VisualContext.ColorScheme;
        resp.result = new JObject();
        resp.result["theme"] = theme;
    }
    else if (data.method.Contains("requestThemeRes"))
    {
        resp.code = 0;
        var dictionary =
_ContextInjection.ThisApplicationContext.GlobalContexts.VisualContext.ThemeResources;
        resp.result = JToken.FromObject(dictionary);
    }

    return resp;
}

private void HandleSubscribe(ICosmosRpcRequest data)
{
    // 处理SDK发送的Subscribe消息（类HandleNotify处理）
}

```

客户端 (SDK)

分别以C# (TestWpf项目) 和C++ (TestMfc项目) 举例说明。

C#示例

文件: MainWindow.xaml.cs

流程: 1) 导入SDK的导出函数 (见服务端导出接口7个), 导入API接口 (用于设置窗口关系、风格、位置等, 后续介绍)

- 2) 解析命令行参数 (第一个参数: 管道名称; 第二个参数: 服务端窗口信息 (见: \$" {hwnd} | {(int)actualWidth} | {(int)actualHeight}")
- 3) 注册 Loaded 和 SourceInitialized 事件 (SourceInitialized: 设置父子关系, 适配子窗口位置尺寸; Loaded : 注册管道回调函数, 连接管道)
- 4) 收发业务通信处理

1) 进程入口

```
// 启动进程, 解析参数, 显示窗口 (注: 入口文件 App.xaml.cs; 其他文件均为:  
MainWindow.xaml.cs)  
namespace Testwpf  
{  
    public partial class App : Application  
    {  
        [DllImport("kernel32")]  
        static extern bool AllocConsole();  
        protected override void OnStartup(StartupEventArgs e)  
        {  
            base.OnStartup(e);  
  
            // 解析命令行参数  
            string[] args = e.Args;  
            if (args.Length > 0)  
            {  
                MainWindow mainwindow = new MainWindow();  
                if (args.Length > 1)  
                {  
                    // 设置管道名称, 窗口信息  
                    mainwindow._pipeName = args[0];  
                    mainwindow._wndInfo = args[1];  
                }  
                mainwindow.Show();  
            }  
            else  
            {  
                // 没有命令行参数  
                MainWindow mainwindow = new MainWindow();  
                mainwindow.Show();  
            }  
        }  
    }  
}
```

2) SDK接口封装

```
using System;
using System.Runtime.InteropServices;
using System.Runtime.Serialization;
using System.Text;
using System.Text.Json.Nodes;
using System.Threading;

//using System.Text.Encoding.CodePages;
using Newtonsoft.Json;
using Newtonsoft.Json.Linq;

namespace RpcWrapper
{
    public class CSharpRpcWrapper
    {
        // 定义 C++ 枚举类型
        public enum RET_CALL
        {
            Exception = -3,
            Sendfail = -2,
            Timeout = -1,
            Pipenull = 0,
            Ok = 1
        }

        /// <summary>
        /// 消息调用类型枚举，定义不同范围的消息发送方式。
        /// </summary>
        public enum InvokeType
        {
            Instance,

            /// <summary>
            /// 给具体实例发送消息，直接针对某个特定对象。
            /// </summary>
            Group,

            /// <summary>
            /// 给某类的所有组件实例发送消息，作用于该类型的全部实例。
            /// </summary>
            Global
        }

        public class RpcRequest
        {
            public string id = "";
            public string method;
            public JObject param;
        }

        public class RpcResponse
        {
```

```

        public string id = "";
        public int code = -1;
        public JToken error = JValue.CreateNull();
        public JToken result = JValue.CreateNull();
    }

    public class RpcPush
    {
        public string topic= "";
        public JToken param;
    }

    public delegate RpcResponse OnInvokeDelegate(RpcRequest param);
    public delegate void OnNotifyDelegate(RpcRequest param);
    public delegate void OnSubscribeDelegate(RpcRequest param);
    public delegate void OnPushDelegate(RpcPush param);
    public delegate void OnFreeVoidPtrDelegate(IntPtr param);

    public event OnInvokeDelegate OnInvoke;
    public event OnNotifyDelegate OnNotify;
    public event OnSubscribeDelegate OnSubscribe;
    public event OnPushDelegate OnPush;
    public event OnFreeVoidPtrDelegate OnFreeVoidPtr;

    // 定义 C++ 委托类型
    [UnmanagedFunctionPointer(CallingConvention.Cdecl)]
    public delegate IntPtr CPPOnInvokeDelegate(IntPtr param, int size);

    [UnmanagedFunctionPointer(CallingConvention.Cdecl)]
    public delegate void CPPOnNotifyDelegate(IntPtr param, int size);

    [UnmanagedFunctionPointer(CallingConvention.Cdecl)]
    public delegate void CPPOnSubscribeDelegate(IntPtr param, int size);

    [UnmanagedFunctionPointer(CallingConvention.Cdecl)]
    public delegate void CPPOnPushDelegate(IntPtr param, int size);

    [UnmanagedFunctionPointer(CallingConvention.Cdecl)]
    public delegate void CPPOnFreeVoidPtrDelegate(IntPtr param);

    // 定义回调函数
    private static CPPOnInvokeDelegate cpp_onInvoke;
    private static CPPOnNotifyDelegate cpp_onNotify;
    private static CPPOnSubscribeDelegate cpp_onSubscribe;
    private static CPPOnPushDelegate cpp_onPush;
    private static CPPOnFreeVoidPtrDelegate cpp_onFreeVoidPtr;

    // 导入 C++ 函数
    [DllImport("PipeClient.dll", CallingConvention =
CallingConvention.Cdecl)]
    public static extern bool InitClient(IntPtr pipename, int pipename_size,
IntPtr logpath, int log_path_size, int protocolLevel, double del_log_cycle, bool
bdetaillog);

    [DllImport("PipeClient.dll", CallingConvention =
CallingConvention.Cdecl)]
    public static extern int Invoke(IntPtr _in, ref IntPtr _out, out int
_outsize, int timeout = 30000);

```

```
[DllImport("PipeClient.dll", CallingConvention =
 CallingConvention.Cdecl)]
public static extern int Notify(IntPtr _in);

[DllImport("PipeClient.dll", CallingConvention =
 CallingConvention.Cdecl)]
public static extern int Subscribe(IntPtr _in);

[DllImport("PipeClient.dll", CallingConvention =
 CallingConvention.Cdecl)]
public static extern int Push(IntPtr _in);

[DllImport("PipeClient.dll", CallingConvention =
 CallingConvention.Cdecl)]
public static extern IntPtr CreateRpcRequest(string id, string method,
IntPtr param);

[DllImport("PipeClient.dll", CallingConvention =
 CallingConvention.Cdecl)]
public static extern IntPtr CreateRpcPush(string topic, IntPtr param);

[DllImport("PipeClient.dll", CallingConvention =
 CallingConvention.Cdecl)]
public static extern void FreeRpcAllocMemory(IntPtr _in);

[DllImport("PipeClient.dll", CallingConvention =
 CallingConvention.Cdecl)]
public static extern void Register(CPPOnInvokeDelegate invoke,
CPPOnNotifyDelegate notify, CPPOnSubscribeDelegate subscribe, CPPOnPushDelegate
push, CPPOnFreeVoidPtrDelegate freevoidptr);

[DllImport("Pipeclient.dll", CallingConvention =
 CallingConvention.Cdecl)]
public static extern void ExitApp();

public CSharpRpcWrapper()
{
    Encoding.RegisterProvider(CodePagesEncodingProvider.Instance);
}

public bool InitClient(string pipename, string logpath, double
del_log_cycle = 3, bool bdetaillog = false)
{
    IntPtr pipenamePtr = Marshal.StringToCoTaskMemAnsi(pipename);
    IntPtr logpathPtr = Marshal.StringToCoTaskMemAnsi(logpath);

    bool bRet = InitClient(pipenamePtr, pipename.Length, logpathPtr,
logpath.Length, 2, del_log_cycle, bdetaillog);
    Marshal.FreeCoTaskMem(pipenamePtr);
    Marshal.FreeCoTaskMem(logpathPtr);
    return bRet;
}

public void RegisterCallback()
{
    // 注册回调函数
    cpp_onInvoke = new CPPOnInvokeDelegate(On_Invoke);
}
```

```

        cpp_onNotify = new CPPOnNotifyDelegate(On_Notify);
        cpp_onPush = new CPPOnPushDelegate(On_Push);
        cpp_onSubscribe = new CPPOnSubscribeDelegate(On_Subscribe);
        cpp_OnFreeVoidPtr = new CPPOnFreeVoidPtrDelegate(On_FreeBusiparam);

        Register(cpp_onInvoke, cpp_onNotify, cpp_onSubscribe, cpp_onPush,
        cpp_OnFreeVoidPtr);
    }

    private IntPtr On_Invoke(IntPtr param, int size)
    {
        try{
            RpcRequest request = DeserializeRpcRequest(param, size);

            RpcResponse resp = OnInvoke?.Invoke(request) ??
default(RpcResponse);

            string msg = JsonConvert.SerializeObject(resp);
            IntPtr _out = Marshal.StringToHGlobalAnsi(msg);
            return _out;
        }
        catch (Exception ex) {

            return IntPtr.Zero;
        }
    }

    private void On_Notify(IntPtr param, int size)
    {
        RpcRequest request = DeserializeRpcRequest(param, size);
        OnNotify?.Invoke(request);
    }

    private void On_Subscribe(IntPtr param, int size)
    {
        RpcRequest request = DeserializeRpcRequest(param, size);
        OnSubscribe?.Invoke(request);
    }

    private void On_Push(IntPtr param, int size)
    {
        RpcPush push = DeserializeRpcPush(param, size);
        OnPush?.Invoke(push);
    }

    private void On_FreeBusiparam(IntPtr param)
    {
        Marshal.FreeHGlobal(param);
    }

    public int Invoke(RpcRequest request, out RpcResponse response, int
timeout = 30000)
    {
        IntPtr _in = CreatePpcPtrByRequest(request);

        IntPtr _out = IntPtr.Zero;
        int _outsize = 0;
        int ret = Invoke(_in, ref _out, out _outsize, timeout);
    }
}

```

```

        FreeRpcAllocMemory(_in);

        response = DeserializeRpcResponse(_out, _outsize);
        FreeRpcAllocMemory(_out);
        return ret;
    }

    public async Task<(int ret, RpcResponse response)>
InvokeAsync(RpcRequest request, int timeout = 30000)
{
    RpcResponse response = new RpcResponse();
    int ret = await Task.Run(() => Invoke(request, out response,
timeout));

    return (ret, response);
}

public int Notify(RpcRequest request)
{
    IntPtr _in = CreatePpcPtrByRequest(request);

    int ret = Notify(_in);
    FreeRpcAllocMemory(_in);
    return ret;
}

/// <summary>
/// 向组件发送请求
/// </summary>
/// <param name="InstanceId">发送对象，根据type填入不同的参数</param>
/// <param name="type">发送对象类型</param>
/// <param name="parameter">发送内容</param>
/// <param name="currentPage">是否只发送给当前页面</param>
public async Task<(int ret, RpcResponse response)> Invokewidget(string
InstanceId, InvokeType type, RpcRequest parameter, bool currentPage = false)
{
    var widgetPackage = Packwidget(InstanceId, type, parameter,
currentPage);
    return await InvokeAsync(parameter);
}

/// <summary>
/// 发送消息给组件
/// </summary>
/// <param name="InstanceId">发送对象，根据type填入不同的参数</param>
/// <param name="type">发送对象类型</param>
/// <param name="parameter">发送内容</param>
/// <param name="currentPage">是否只发送给当前页面</param>
public int Notifywidget(string Instanceid, InvokeType type, RpcRequest
parameter, bool currentPage = false)
{
    var widgetPackage = PackWidget(InstanceId, type, parameter,
currentPage);
    return Notify(widgetPackage);
}

private RpcRequest PackWidget(string Instanceid, InvokeType type,
RpcRequest parameter, bool currentPage = false)

```

```

{
    JObject widgetParam = new JObject();
    widgetParam["method"] = parameter.method;
    widgetParam["type"] = (int)type;
    widgetParam["currentPage"] = currentPage;
    widgetParam["instanceid"] = Instanceid;

    if (parameter.param is null)
    {
        parameter.param = new JObject();
    }
    parameter.param["Cosmos:WidgetComunication:Invoke"] = widgetParam;
    parameter.method = "Cosmos:WidgetComunication:Invoke";

    return parameter;
}

public int Subscribe(RpcRequest request)
{
    IntPtr _in = CreatePpcPtrByRequest(request);
    int ret = Subscribe(_in);
    FreeRpcAllocMemory(_in);
    return ret;
}

private IntPtr CreatePpcPtrByRequest(RpcRequest request)
{
    // 获取 GBK 编码
    Encoding gbkEncoding = Encoding.GetEncoding("GBK");

    // 转换为 GBK 编码的字节数组
    string input = request.param?.ToString() ?? "{}";
    byte[] gbkBytes = gbkEncoding.GetBytes(input);

    // 分配内存并复制字节数组
    IntPtr ptr = Marshal.AllocHGlobal(gbkBytes.Length);
    Marshal.Copy(gbkBytes, 0, ptr, gbkBytes.Length);

    IntPtr _out = CreateRpcRequest(request.id, request.method, ptr);

    // 释放内存
    Marshal.FreeHGlobal(ptr);
}

return _out;
}

public int Push(RpcPush push)
{
    // 获取 GBK 编码
    Encoding gbkEncoding = Encoding.GetEncoding("GBK");

    // 转换为 GBK 编码的字节数组
    string input = push.param?.ToString() ?? "{}";
    byte[] gbkBytes = gbkEncoding.GetBytes(input);

    // 分配内存并复制字节数组
    IntPtr ptr = Marshal.AllocHGlobal(gbkBytes.Length);
    Marshal.Copy(gbkBytes, 0, ptr, gbkBytes.Length);
}

```

```
    IntPtr _in = CreateRpcPush(push.topic, ptr);

    // 释放内存
    Marshal.FreeHGlobal(ptr);

    int ret = Push(_in);
    FreeRpcAllocMemory(_in);
    return ret;
}

public void Exit()
{
    ExitApp();
}

private RpcRequest DeserializeRpcRequest(IntPtr param, int size)
{
    RpcRequest request = new RpcRequest();
    if (param != IntPtr.Zero)
    {
        // 将 IntPtr 转换为字节数组
        byte[] gbkBytes = new byte[size];
        Marshal.Copy(param, gbkBytes, 0, size);

        // 将 GBK 字节数组解码为 UTF-8 字符串
        string gbkString =
Encoding.GetEncoding("GBK").GetString(gbkBytes);
        string utf8String =
Encoding.UTF8.GetString(Encoding.Convert(Encoding.GetEncoding("GBK"),
Encoding.UTF8, gbkBytes));

        JObject jt = JObject.Parse(utf8String);
        if (jt.ContainsKey("id") && jt["id"] != null)
        {
            request.id = (string)jt["id"];
        }

        if (jt.ContainsKey("method") && jt["method"] != null)
        {
            request.method = (string)jt["method"];
        }

        if (jt.ContainsKey("param"))
        {
            request.param = jt["param"];
        }
    }
    else
    {
        // 处理 param 为 null 的情况
    }

    return request;
}

private RpcResponse DeserializeRpcResponse(IntPtr param, int size)
{
    RpcResponse resp = new RpcResponse();
```

```
        if (param != IntPtr.Zero)
    {
        // 将 IntPtr 转换为字节数组
        byte[] gbkBytes = new byte[size];
        Marshal.Copy(param, gbkBytes, 0, size);

        // 将 GBK 字节数组解码为 UTF-8 字符串
        string gbkString =
Encoding.GetEncoding("GBK").GetString(gbkBytes);
        string utf8String =
Encoding.UTF8.GetString(Encoding.Convert(Encoding.GetEncoding("GBK"),
Encoding.UTF8, gbkBytes));

        var jt = JObject.Parse(utf8String);
        if (jt.ContainsKey("id") && jt["id"] != null)
        {
            resp.id = (string)jt["id"];
        }

        if (jt.ContainsKey("code") && jt["code"] != null)
        {
            resp.code = (Int32)jt["code"];
        }

        if (jt.ContainsKey("error"))
        {
            resp.error = jt["error"];
        }

        if (jt.ContainsKey("result"))
        {
            resp.result = jt["result"];
        }
    }

    return resp;
}

private RpcPush DeserializeRpcPush(IntPtr param, int size)
{
    RpcPush push = new RpcPush();
    if (param != IntPtr.Zero)
    {
        // 将 IntPtr 转换为字节数组
        byte[] gbkBytes = new byte[size];
        Marshal.Copy(param, gbkBytes, 0, size);

        // 将 GBK 字节数组解码为 UTF-8 字符串
        string gbkString =
Encoding.GetEncoding("GBK").GetString(gbkBytes);
        string utf8String =
Encoding.UTF8.GetString(Encoding.Convert(Encoding.GetEncoding("GBK"),
Encoding.UTF8, gbkBytes));

        JObject jt = JObject.Parse(utf8String);
        if (jt.ContainsKey("topic") && jt["topic"] != null)
        {
            push.topic = (string)jt["topic"];
        }
    }
}
```

```

        }

        if (jt.ContainsKey("param"))
        {
            push.param = jt["param"];
        }
    }

    return push;
}
}
}

```

3) 构造初始化

```

private CSharpRpcwrapper wrapper = new CSharpRpcwrapper(); // SDK接口封装对象

// 窗口构造初始化
public Mainwindow()
{
    InitializeComponent();
    this.Loaded += MainWindow_Loaded;
    this.SourceInitialized += Mainwindow_SourceInitialized;

    // 注册SDK消息
    wrapper.OnInvoke += On_Invoke;
    wrapper.OnPush += On_Push;
    wrapper.OnNotify += On_Notify;
    wrapper.OnSubscribe += On_Subscribe;
}

```

4) 父子关系，尺寸适配

```

private void Mainwindow_SourceInitialized(object sender, EventArgs e)
{
    this.SourceInitialized -= Mainwindow_SourceInitialized;
    if(string.IsNullOrEmpty(_wndInfo))
    {
        return;
    }

    string[] parts = _wndInfo.Split('|');
    if (parts.Length > 2)
    {
        // 设置父子关系和窗口位置
        string msg = parts[0];
        string strwidth = parts[1];
        string strheight = parts[2];

        int parHandle = 0;
        int.TryParse(msg, out parHandle);
        curHwnd = new WindowInteropHelper(this).Handle;
        long lPreStyle = GetWindowLong(curHwnd, -16);
        long lPreExStyle = GetWindowLong(curHwnd, -20);

        lPreStyle &= ~WS_POPUP;
    }
}

```

```

    lPreStyle |= WS_CHILD;
    lPreStyle &= ~(WS_BORDER | WS_THICKFRAME | WS_DLGFREAME);
    lPreExStyle &= ~(WS_EX_WINDOWEDGE | WS_EX_CLIENTEDGE);
    SetwindowLong(curHwnd, -16, lPreStyle);
    SetwindowLong(curHwnd, -20, lPreExStyle);
    SetParent(curHwnd, parHandle);
    WindowStyle = WindowStyle.None;
    ResizeMode = ResizeMode.NoResize;

    double width = 0;
    double.TryParse(strwidth, out width);
    double height = 0;
    double.TryParse(strheight, out height);
    Movewindow(curHwnd, 0, 0, (int)width, (int)height, false);
    InvalidateRect(curHwnd, IntPtr.Zero, true);
    Updatewindow(curHwnd);
}

}

private double lastwidth = 0;
private double lastHeight = 0;
private double lastScaling = 1;

private async void Updatewindow()
{
    await Task.Delay(300);

    Application.Current.Dispatcher.BeginInvoke(new Action(() =>
    {

        Movewindow(curHwnd, 0, 0, (int)lastwidth, (int)lastHeight, false);
        InvalidateRect(curHwnd, IntPtr.Zero, true);
        Updatewindow(curHwnd);

        InvalidateMeasure();
        InvalidateArrange();
        UpdateLayout();
    }));
}
}

```

5) 注册回调、连接管道

```

private void Mainwindow_Loaded(object sender, RoutedEventArgs e)
{
    this.Loaded -= Mainwindow_Loaded;

    // 注册回调函数
    RegisterCallBack();

    // 连接管道
    Connect();
}

// 注册回调函数（注：回调函数实现在6）消息发送及响应中介绍）
private void RegisterCallBack()
{
    wrapper.RegisterCallback();
}

```

```

}

// 连接管道
private void Connect()
{
    string log_path = "test_rpc_wpf.log"; // 管道日志文件
    if (string.IsNullOrEmpty(_pipeName))
        return;

    if (!InitClient(Marshal.StringToCoTaskMemAnsi(_pipeName), _pipeName.Length,
        Marshal.StringToCoTaskMemAnsi(log_path), log_path.Length))
    {
        MessageBox.Show("连接失败");
        return;
    }

    _pipeSucc = true;

    // 发送初始化消息
    RpcRequest request = new RpcRequest();
    request.id = Guid.NewGuid().ToString();
    request.method = "init_succ";
    wrapper?.Notify(request);
}

```

6) 消息发送及响应

```

// 消息发送（点击界面按钮）
private void Button_Click(object sender, RoutedEventArgs e)
{
    // 获取触发事件的按钮
    Button button = sender as Button;

    if (button != null)
    {
        switch (button.Name)
        {
            case "notify":
                {
                    if (_pipeSucc)
                    {
                        // 向 Cosmos 发送 Notify 消息
                        RpcRequest request = new RpcRequest();
                        request.id = Guid.NewGuid().ToString();
                        request.method = "notf_sub";
                        wrapper?.Notify(request);
                    }
                    else
                        MessageBox.Show("请先建立连接");
                    break;
                }
            case "push":
                {
                    if (_pipeSucc)
                    {
                        // 向 Cosmos 发送 Push 消息
                        string strSubkey = "sub_account_123456";

```

```
        if (g_setSub.Contains(strSubkey))
        {
            // 说明订阅过该key，则可以推送数据
            RpcPush push = new RpcPush();
            push.topic = "push_account";
            push.param = new JObject
            {
                ["ID"] = "123456",
                ["Type"] = 1,
                ["Status"] = 1
            };
            wrapper?.Push(push);
        }
    }
    else
        MessageBox.Show("请先建立连接");
    break;
}
case "invokeAsync":
{
    if (_pipeSucc)
    {
        TestMethodInvokeAsync();
        MessageBox.Show("异步测试后续流程 - 不阻塞");
    }
    else
        MessageBox.Show("请先建立连接");
    break;
}
case "invoke":
{
    if (_pipeSucc)
    {
        TestMethodInvoke();
        MessageBox.Show("同步测试后续流程 - 被阻塞");
    }
    else
        MessageBox.Show("请先建立连接");
    break;
}
case "requestThemeRes":
{
    // 先获取到颜色资源字典
    RequestThemeRes();
    break;
}
case "requestTheme":
{
    // 获取到颜色资源字典后
    // 获取主题 根据主题加载对应资源
    RequestTheme();
    break;
}
case "DemoButton":
{
    break;
}
}
```

```

        }

    }

    // 测试异步Invoke方法
    private async Task TestMethodInvokeAsync()
    {
        RpcRequest request = new RpcRequest();
        request.id = Guid.NewGuid().ToString();
        request.method = "test_invoke_async";

        var (ret, response) = await wrapper.InvokeAsync(request);
        if (RET_CALL.Ok == (RET_CALL)ret)
        {
            MessageBox.Show("异步测试结果返回");
        }
    }

    // 测试同步Invoke方法
    private void TestMethodInvoke()
    {
        RpcRequest request = new RpcRequest();
        request.id = Guid.NewGuid().ToString();
        request.method = "test_invoke";
        RpcResponse response = new RpcResponse();

        int interval = 30000;
        int ret = wrapper.Invoke(request, out response);
        if (RET_CALL.Ok == (RET_CALL)ret)
        {
            MessageBox.Show("同步测试结果返回");
        }
    }

    // 请求皮肤（向 Cosmos 发送 Invoke 请求）
    private void RequestTheme()
    {
        if (wrapper is not null)
        {
            RpcRequest request = new RpcRequest();
            request.method = "requestTheme";
            RpcResponse response = new RpcResponse();
            int ret = wrapper.Invoke(request, out response);
            if (ret == 1 && response.code == 0)
            {
                var converter = new BrushConverter();

                theme = response.result["theme"].ToString();
                Dictionary<string, object>? colorDic = _themeResources?[theme];

                ResourceDictionary resourceDict = new ResourceDictionary();
                foreach (KeyValuePair<string, object> kvp in colorDic)
                {
                    resourceDict.Add(kvp.Key, converter.ConvertFrom(kvp.Value));
                }
                if (Application.Current.Resources.MergedDictionaries.Count == 0)
                {
                    Application.Current.Resources.MergedDictionaries.Add(resourceDict);
                }
            }
        }
    }
}

```

```

        }
        else
        {
            Application.Current.Resources.MergedDictionaries[0] =
resourceDict;
        }

        DemoButton.SetResourceReference(Button.BackgroundProperty, "color-
background2");
        DemoButton.SetResourceReference(Button.ForegroundProperty, "color-
font5");
    }
}

// 请求主题资源（向 Cosmos 发送 Invoke 请求）
private void RequestThemeRes()
{
    if(wrapper is not null)
    {
        RpcRequest request = new RpcRequest();
        request.method = "requestThemeRes";
        RpcResponse response = new RpcResponse();
        int ret = wrapper.Invoke(request, out response);
        if (ret == 1 && response.code == 0)
        {
            string outputMessage = response.result.ToString();
            _themeResources =
Newtonsoft.Json.JsonConvert.DeserializeObject<Dictionary<string,
Dictionary<string, object>>>(outputMessage);
        }
    }
}

// 消息响应
private RpcResponse On_Invoke(RpcRequest request)
{
    RpcResponse resp = new RpcResponse();
    resp.id = request.id;
    resp.code = 0; //默认设置成功

    string strMethod = (string)request.method;
    if (strMethod == "qry_account")
    {
        // 查询账户
        string id = (string)request.param["ID"];
        if (id == "ALL")
        {
            // 查询所有账户信息
            List<AccountInfo> accounts = new List<AccountInfo>
            {
                new AccountInfo { ID = "123456", Type = 1, Status = 1 },
                new AccountInfo { ID = "456789", Type = 2, Status = 0 }
            };
            resp.result = JToken.FromObject(accounts);
        }
        else if (id == "123456")
    }
}

```

```

    {
        // 查询指定账户ID的账户信息（假设 ID 为 "123456"，即返回账户123456的信息）
        resp.result = new JObject
        {
            ["ID"] = "123456",
            ["Type"] = 1,
            ["Status"] = 1,
        };
    }
    else
    {
        resp.code = -1;
        resp.error = new JObject
        {
            ["msg"] = "未找到查询的账户ID",
        };
    }
}
else
{
    // 其他查询业务
}

return resp;
}

private async void On_Notify(RpcRequest request)
{
    if (request.method == "setsize")
    {
        // 调整尺寸位置
        double scaling = (double)request.param["curscaling"];
        double dpiratio = (double)request.param["dpiRatio"];
        double width = (double)request.param["width"] * dpiratio;
        double height = (double)request.param["height"] * dpiratio;

        if (lastwidth == width && lastHeight == height && lastScaling == scaling)
        {
            return;
        }
        else
        {
            lastwidth = width;
            lastHeight = height;
            lastScaling = scaling;

            UpdateWindow();
        }
    }
    else if (request.method == "close")
    {
        // 关闭
        Application.Current.Dispatcher.BeginInvoke(new Action(() =>
        {
            this.Close();
        }));
    }
}

```

```

        else if(request.method == "SchemeChanged")
        {
            // 主题切换
            Dispatcher.Invoke(() =>
            {
                theme = (string)request.param["theme"];
                var converte = new BrushConverter();

                Dictionary<string, object>? colorDic = _themeResources?[theme];

                ResourceDictionary resourceDict = new ResourceDictionary();
                foreach (KeyValuePair<string, object> kvp in colorDic)
                {
                    resourceDict.Add(kvp.Key, converte.ConvertFrom(kvp.Value));
                }
                if (Application.Current.Resources.MergedDictionaries.Count == 0)
                {

                    Application.Current.Resources.MergedDictionaries.Add(resourceDict);
                }
                else
                {
                    Application.Current.Resources.MergedDictionaries[0] =
                    resourceDict;
                }
            });
        }
        else
        {
            // 其他通知业务
        }
    }

    private void On_Push(RpcPush push)
    {
        // 根据 topic 判断具体业务
        if (push.topic == "push_account")
        {
            // 推送账户信息
            string strID = (string)push.param["ID"];
            if (g_mapActInfo.ContainsKey(strID))
            {
                g_mapActInfo[strID].Type = (int)push.param["Type"];
                g_mapActInfo[strID].Status = (int)push.param["Status"];
            }
        }
        else
        {
            // 其他推送业务
        }
    }

    private void On_Subscribe(RpcRequest request)
    {
        if (request.method == "sub_account")
        {
            // 订阅账户
        }
    }
}

```

```

if (!string.IsNullOrEmpty((string)request.param["ID"]))
{
    // 缓存订阅的key
    string strSubkey = $"{request.method}_{request.param["ID"]}";
    g_SetSub.Add(strSubkey);
}
else
{
    // 其他订阅业务
}
}

```

C++示例（MFC）

文件：Test.cpp

- 流程：
- 1) 加载SDK库，获取SDK导出接口函数地址；注册回调函数
 - 2) 解析命令行参数（第一个参数：管道名称；第二个参数：服务端窗口信息（见： \${hwnd}|{(int)actualWidth}|{(int)actualHeight}" ）
 - 3) 调整窗口属性（设置父子关系，窗口风格），移动窗口位置（嵌入贴满父窗口中）
 - 4) 开启消息循环（可处理服务端进程发送的消息）

1) App实例初始化

```

// 文件: Test.cpp
// 定义回调函数类型
typedef bool (*Bridge_InitClientFunc)(const char*, int, const char*, int,
double, bool);
typedef RET_CALL (*Bridge_InvokeAsyncFunc)(void*, InvokeCallback, int);
typedef RET_CALL (*Bridge_InvokeWidgetAsyncFunc)(const char*, InvokeType, void*,
bool, InvokeCallback, int);
typedef RET_CALL (*Bridge_InvokeFunc)(void*, void*, int*, int);
typedef RET_CALL (*Bridge_InvokeWidgetFunc)(const char*, InvokeType, void*,
bool, void*, int*, int);
typedef RET_CALL (*Bridge_NotifyFunc)(void*);
typedef RET_CALL (*Bridge_NotifyWidgetFunc)(const char*, InvokeType, void*,
bool);
typedef RET_CALL (*Bridge_SubscribeFunc)(void*);
typedef RET_CALL (*Bridge_PushFunc)(void*);
typedef void (*Bridge_ExitFunc)();
typedef void (*Bridge_RegisterFunc)(OnInvoke, OnNotify, OnSubscribe, OnPush,
OnFreeVoidPtr);

// App实例初始化
BOOL CTestApp::InitInstance()
{
    INITCOMMONCONTROLSEX InitCtrls;
    InitCtrls.dwSize = sizeof(InitCtrls);
    InitCtrls.dwICC = ICC_WIN95_CLASSES;
    InitCommonControlsEx(&InitCtrls);
    CWinApp::InitInstance();
    AfxEnableControlContainer();
    CShellManager *pShellManager = new CShellManager;
}

```

```

CMFCVisualManager::SetDefaultManager(RUNTIME_CLASS(CMFCVisualManagerWindows));
    SetRegistryKey(_T("Local Appwizard-Generated Applications"));

    // 加载进程通信SDK库
    HMODULE hDll = LoadLibraryA("PipeClient.dll");
    if (!hDll)
    {
        std::cout << "LoadLibrary failed!";
        return -1;
    }

    // 函数指针
    Bridge_InitClientFunc           initClientFunc =
(Bridge_InitClientFunc)GetProcAddress(hDll, "InitClientForC");
    Bridge_InvokeFunc               invokeFunc =
(Bridge_InvokeFunc)GetProcAddress(hDll, "Invoke");
    Bridge_InvokeWidgetFunc         invokeWidgetFunc =
(Bridge_InvokeWidgetFunc)GetProcAddress(hDll, "InvokeWidget");
    Bridge_InvokeAsyncFunc          invokeAsyncFunc =
(Bridge_InvokeAsyncFunc)GetProcAddress(hDll, "InvokeAsync");
    Bridge_InvokeWidgetAsyncFunc    invokeWidgetAsyncFunc =
(Bridge_InvokeWidgetAsyncFunc)GetProcAddress(hDll, "InvokeWidgetAsync");
    Bridge_NotifyFunc              notifyFunc =
(Bridge_NotifyFunc)GetProcAddress(hDll, "Notify");
    Bridge_NotifyWidgetFunc        notifyWidgetFunc =
(Bridge_NotifyWidgetFunc)GetProcAddress(hDll, "NotifyWidget");
    Bridge_SubscribeFunc           subscribeFunc =
(Bridge_SubscribeFunc)GetProcAddress(hDll, "Subscribe");
    Bridge_PushFunc                pushFunc =
(Bridge_PushFunc)GetProcAddress(hDll, "Push");
    Bridge_ExitFunc                exitFunc =
(Bridge_ExitFunc)GetProcAddress(hDll, "ExitApp");
    Bridge_RegisterFunc            registerCallbackFunc =
(Bridge_RegisterFunc)GetProcAddress(hDll, "Register");

    // 1、注册回调
    registerCallbackFunc(HandleInvoke, HandleNotify, HandleSubscribe,
HandlePush, HandleFreevoid);

    // 2.解析命令行参数、获取父窗口句柄和初始大小
    std::string cmdLine = GetCommandLineA();
    std::vector<std::string> vecArg;
    SplitString(cmdLine, ' ', vecArg);

    std::string strPipeName;
    HWND hParent = 0;
    RECT rect = { 0 };
    if (vecArg.size() > 2)
    {
        //解析第一个命令行参数，管道名
        strPipeName = vecArg[1];

        // 解析第二个命令行参数，句柄+初始化大小
        std::string InitArg = vecArg[2];
        std::vector<std::string> vecInit;
        SplitString(InitArg, '|', vecInit);
        if (vecArg.size() > 2)

```

```

    {
        hParent = (HWND)std::stol(vecInit[0].c_str());
        rect.right = std::stol(vecInit[1].c_str());
        rect.bottom = std::stol(vecInit[2].c_str());
    }
}

pDlg = new CTestDlg();
pDlg->Create(IDD_TEST_DIALOG, hParent ? CWnd::FromHandle(hParent):
(CWnd*)this);

//调整窗口属性
if (hParent != 0)
{
    HWND hWnd = pDlg->GetSafeHwnd();
    LONG lPreStyle = GetWindowLong(hWnd, GWL_STYLE);
    LONG lPreExStyle = GetWindowLong(hWnd, GWL_EXSTYLE);
    lPreStyle &= ~WS_POPUP;
    lPreStyle |= WS_CHILD;

    lPreStyle &= ~(WS_BORDER | WS_THICKFRAME | WS_DLGFRADE);

    lPreExStyle &= ~(WS_EX_WINDOWEDGE | WS_EX_CLIENTEDGE);

    SetWindowLong(hWnd, GWL_STYLE, lPreStyle);
    SetWindowLong(hWnd, GWL_EXSTYLE, lPreExStyle);
    pDlg->SetParent(CWnd::FromHandle(hParent));
}

//移动窗口位置
if (rect.right > 0 || rect.bottom > 0)
{
    pDlg->MoveWindow(&rect);
}

//消息循环
MSG msg = { 0 };
while (::GetMessage(&msg, NULL, 0, 0))
{
    if (msg.message == WM_QUIT)
    {
        break;
    }
    else if (msg.message == WM_USER_INIT)
    {
        // 处理初始化消息
        {
            std::lock_guard<std::mutex> lock(g_mutex);
            g_dlgHwnd = pDlg->GetSafeHwnd();
        }
        std::string log_path = "test_rpc_cc.log"; // 进程日志
        if (!strPipeName.empty())
        {
            // 1、启动管道
            if (!initClientFunc(strPipeName.c_str(), strPipeName.length(),
log_path.c_str(), log_path.size() + 1))
            {
                std::cout << "InitClient failed!";
            }
        }
    }
}

```

```

        return -1;
    }
    else
    {
        //启动成功，通知对方初始化完成
        RpcRequest param;
        param.id = app::GetUuid();
        param.method = "init_succ";
        notifyFunc(&param); // 向 Cosmos 发送 Notify 消息
    }
}
else if (msg.message == WM_USER_SETPOS)
{
    // 适配位置尺寸
    int len = (int)msg.wParam;
    int height = (int)msg.lParam;
    pDlg->SetWindowSize(len, height);
    pDlg->>ShowWindow(SW_SHOW);
}
else if (msg.message == WM_USER_TEST_INVOKE)
{
    int type = (int)msg.wParam;
    int interval = 30000;

    if (type == 1)
    {
        // 同步测试
        {
            RpcRequest param;
            param.id = app::GetUuid();
            param.method = "test_invoke";
            int outsize = 0;
            RpcResponse* out = new RpcResponse();
            RET_CALL ret = invokeFunc(&param, (void*)&out, &outsize,
interval);
            if (ret == RET_CALL::ok)
            {
                int code = out->code;
                std::string id = out->id;
                Json::FastWriter writer;
                std::string strresult = writer.write(out->result);
                AfxMessageBox(_T("同步测试结果正常返回"), MB_OK);
            }
            else
            {
                // undo
            }
        }
        AfxMessageBox(_T("同步测试后续流程 - 被阻塞"), MB_OK);
    }
    else if (type == 2)
    {
        // 异步测试
        {
            RpcRequest* param = new RpcRequest();
            param->id = app::GetUuid();
            param->method = "test_invoke_async";
        }
    }
}

```

```

        int outsize = 0;
        invokeAsyncFunc(param, InvokeAsyncCallback, interval);
    }
    AfxMessageBox(_T("异步测试后续流程 - 不阻塞"), MB_OK);
}
}

else if (msg.message == WM_USER_QRY_ACCOUNTINFO)
{
    // 通知 Cosmos 来查询和订阅
    RpcRequest param;
    param.id = app::GetUuid();
    param.method = "notf_sub";
    notifyFunc(&param);
}

else if (msg.message == WM_USER_PUSH_ACCOUNTINFO)
{
    // 要推送的账户数据 123456, 假设组成key为
    std::string strSubkey = "sub_account_123456";
    auto it = g_setSub.find(strSubkey);
    if (it != g_setSub.end())
    {
        // 说明订阅过该key, 则可以推送数据
        RpcPush param;
        param.topic = "push_account";
        param.param = nlohmann::json{
            {"ID", "123456"},      // 资金账户id: 123456
            {"Type", 1},           // 账户类型: 1-普通
            {"Status", 1}          // 账户状态: 1-在线
        };

        pushFunc(&param);    // 向 Cosmos 推送 Push 消息
    }
}

else if (msg.message == WM_USER_RECV_SUB)
{
    CString strCstr = L"收到对方查询和订阅请求，并成功处理";
    pDlg->UpdateText(strCstr);
}

else if (msg.message == WM_USER_SENDWIDGET_REQ)
{
    int interval = 30000;
    CString* pStrFormat = (CString*)msg.wParam;
    if (pStrFormat)
    {
        CString str = *pStrFormat;
        std::vector<CString> vecString;
        int pos = 0;
        int len = str.GetLength();

        while (pos < len) {
            int nextPos = str.Find(_T(' '|'), pos); // 查找分隔符位置
            if (nextPos == -1) {
                nextPos = len; // 未找到分隔符时, 取剩余字符串
            }
            CString token = str.Mid(pos, nextPos - pos); // 提取子字符串
            vecString.push_back(token);
            pos = nextPos + 1; // 移动到分隔符后的位置
        }
    }
}
}

```

```

        std::string strContent = std::string(CT2A(vecString[0]));
        std::string strGroup = std::string(CT2A(vecString[1]));
        std::string strType = std::string(CT2A(vecString[2]));
        int nInvokeType = std::string(CT2A(vecString[3])) == "1" ? 1 :
2;
        RpcRequest request;

        request.method = "textchanged";
        request.param["text"] = Json::Value(strContent);

        //请求
        if (strType == "0")
        {
            int outsize = 0;
            RpcResponse* out = new RpcResponse();
            RET_CALL ret = invokeWidgetFunc(strGroup.c_str(),
(InvokeType)nInvokeType, &request, false, &out, &outsize, interval);
            if (ret == RET_CALL::ok)
            {
                int code = out->code;
                std::string id = out->id;
                Json::FastWriter writer;
                std::string strresult = writer.write(out->result);
                CString strResult;
                strResult.Format(L"返回结果 code:%d, id:%s, result:%s",
code, CString(id.c_str()), CString(strresult.c_str()));
            }
            else
            {
                // undo
            }
        }
        //通知
        else
        {
            notifyWidgetFunc(strGroup.c_str(), (InvokeType)nInvokeType,
&request, false);
        }
    }

    delete pStrFormate;
    pStrFormate = nullptr;
}
::TranslateMessage(&msg);
::DispatchMessage(&msg);
}

// Delete the shell manager created above.
if (pShellManager != nullptr)
{
    delete pShellManager;
}

#if !defined(_AFXDLL) && !defined(_AFX_NO_MFC_CONTROLS_IN_DIALOGS)
ControlBarCleanUp();
#endif

```

```
    return FALSE;  
}
```

2) 窗口初始化

```
// (注: 文件为CTestDlg.cpp, 主要看 发送 初始化 事件 (以启动管道建立连接))  
BOOL CTestDlg::OnInitDialog()  
{  
    CDialogEx::OnInitDialog();  
    ASSERT((IDM_ABOUTBOX & 0xFFFF0) == IDM_ABOUTBOX);  
    ASSERT(IDM_ABOUTBOX < 0xF000);  
  
    CMenu* pSysMenu = GetSystemMenu(FALSE);  
    if (pSysMenu != nullptr)  
    {  
        BOOL bNameValid;  
        CString strAboutMenu;  
        bNameValid = strAboutMenu.LoadString(IDS_ABOUTBOX);  
        ASSERT(bNameValid);  
        if (!strAboutMenu.IsEmpty())  
        {  
            pSysMenu->AppendMenu(MF_SEPARATOR);  
            pSysMenu->AppendMenu(MF_STRING, IDM_ABOUTBOX, strAboutMenu);  
        }  
    }  
  
    SetIcon(m_hIcon, TRUE);           // Set big icon  
    SetIcon(m_hIcon, FALSE);         // Set small icon  
  
    // 发送 初始化 事件 (以启动管道建立连接)  
    PostMessage(WM_USER_INIT, NULL, NULL);  
    return TRUE; // return TRUE unless you set the focus to a control  
}  
  
void CTestDlg::OnBnClickedButton2()  
{  
    // TODO: Add your control notification handler code here  
    // 推送账户信息  
    PostMessage(WM_USER_PUSH_ACCOUNTINFO);  
}  
  
void CTestDlg::OnBnClickedButton3()  
{  
    // TODO: Add your control notification handler code here  
    // 通知查询订阅  
    UpdateText(L"");  
    PostMessage(WM_USER_QRY_ACCOUNTINFO);  
}
```

3) 消息处理

```
// 文件: Test.cpp  
void InvokeAsynCallback(RET_CALL ret, void* _out, int _outsize)  
{  
    RpcResponse* resp = static_cast<RpcResponse*>(_out);  
    if (!resp)  
    {
```

```

    return;
}

if (ret == RET_CALL::Ok)
{
    int code = resp->code;
    std::string id = resp->id;
    Json::FastWriter writer;
    std::string strresult = writer.write(resp->result);
    int i = -1;
    AfxMessageBox(_T("异步测试结果返回"), MB_OK);
}
else
{
    // undo
}
}

void* __cdecl HandleInvoke(void* _in)
{
    // 处理 Cosmos 发送的 Invoke 消息
    if (!_in)
    {
        return nullptr;
    }

    RpcRequest* request = static_cast<RpcRequest*>(_in);
    RpcResponse* resp = new RpcResponse();

    resp->id = request->id;

    // 根据 method 判断具体业务
    if (request->method == "qry_account")
    {
        // 查询账户
        json& js = request->param;
        if (js["ID"] == "ALL")
        {
            // 查询所有账户信息
            json js_array = json::array();
            json js1 = nlohmann::json{
                {"ID", "123456"}, // 资金账户id: 123456
                {"Type", 1}, // 账户类型: 1-普通
                {"Status", 1} // 账户状态: 1-在线
            };

            json js2 = nlohmann::json{
                {"ID", "456789"}, // 资金账户id: 456789
                {"Type", 2}, // 账户类型: 2-信用
                {"Status", 0} // 账户状态: 0-不在线
            };

            js_array.push_back(js1);
            js_array.push_back(js2);
            resp->result = js_array;
            resp->code = 0; // 若想返回报错，则code设置为非0，然后给 resp->error 赋值即可
        }
    }
}

```

```

    else
    {
        if (js["ID"] == "123456")
        {
            // 查询指定账户ID的账户信息（假设 ID 为 "123456"，即返回账户123456的信息）

            json jsAccount = nlohmann::json{
                {"ID", "123456"},      // 资金账户id: 123456
                {"Type", 1},           // 账户类型: 1-普通
                {"Status", 1}          // 账户状态: 1-在线
            };
            resp->result = jsAccount;
            resp->code = 0;
        }
    }

    std::lock_guard<std::mutex> lock(g_mutex);
    if (g_dlgHwnd && ::IsWindow(g_dlgHwnd))
    {
        ::PostMessage(g_dlgHwnd, WM_USER_RECV_SUB, 0, 0);
    }
}
else
{
    // 其他查询业务
}

return (void*)resp;
}

void __cdecl HandleNotify(void* _in)
{
    // 处理 Cosmos 发送的 Notify 消息
    if (!_in)
    {
        return;
    }

    RpcRequest* request = static_cast<RpcRequest*>(_in);
    if (request->method == "setsize")
    {
        // 订阅账户
        json& js = request->param;

        int width = int(js["width"]);
        int height = int(js["height"]);
        {
            std::lock_guard<std::mutex> lock(g_mutex);
            if (g_dlgHwnd && ::IsWindow(g_dlgHwnd))
            {
                ::PostMessage(g_dlgHwnd, WM_USER_SETPOS, (WPARAM)width,
(LPARAM)height);
            }
        }
    }
    else if (request->method == "close")
    {
        // 退出
    }
}

```

```
    exit(0);
}
else
{
    // 其他通知业务
}
}

void __cdecl HandleSubscribe(void* _in)
{
    // 处理 Cosmos 发送的 Subscribe 消息
    if (!_in)
    {
        return;
    }

    RpcRequest* request = static_cast<RpcRequest*>(_in);

    if (request->method == "sub_account")
    {
        // 订阅账户
        json& js = request->param;
        if (!std::string(js["ID"]).empty())
        {
            // 缓存订阅的key
            std::string strSubkey = request->method + "_" +
            std::string(js["ID"]);
            g_setSub.insert(strSubkey);
        }
    }
    else
    {
        // 其他订阅业务
    }
}

void __cdecl HandlePush(void* _in)
{
    // 处理 Cosmos 发送的 Push 消息
    if (!_in)
    {
        return;
    }

    RpcPush* push = static_cast<RpcPush*>(_in);

    // 根据 topic 判断具体业务
    if (push->topic == "push_account")
    {
        // 推送账户信息
        json& js = push->param;
        std::string strID = js["ID"];
        auto it = g_mapActInfo.find(strID);
        if (it != g_mapActInfo.end())
        {
            it->second.Type = js["Type"];
            it->second.Status = js["Status"];
        }
    }
}
```

```

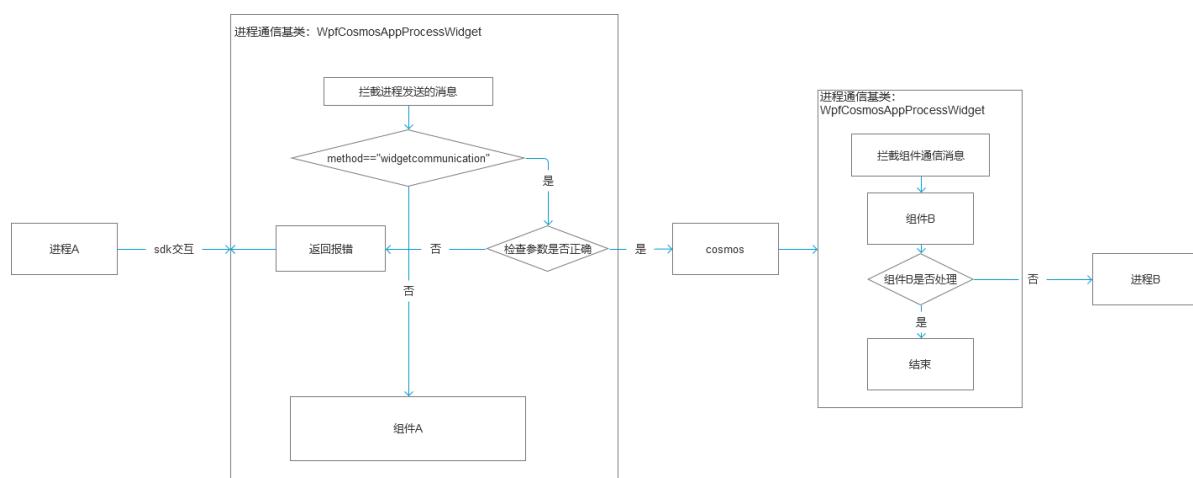
    }
    else
    {
        // 其他推送业务
    }
}

void __cdecl HandleFree(void* param)
{
    // 回调释放内存
    if (param)
    {
        delete param;
        param = nullptr;
    }
}

```

进程消息透传到另一组件

流程图



C#示例

1) 调用

```

/// <summary>
/// 向组件发送请求
/// </summary>
/// <param name="InstanceId">发送对象，根据type填入不同的参数</param>
/// <param name="type">发送对象类型</param>
/// <param name="parameter">发送内容</param>
/// <param name="currentPage">是否只发送给当前页面</param>
public async Task<(int ret, RpcResponse response)> InvokeWidget(string
InstanceId, InvokeType type, RpcRequest parameter, bool currentPage = false)
{
    var widgetPackage = PackWidget(InstanceId, type, parameter, currentPage);
    return await InvokeAsync(parameter);
}

```

2) 通知

```
/// <summary>
/// 发送消息给组件
/// </summary>
/// <param name="InstanceId">发送对象，根据type填入不同的参数</param>
/// <param name="type">发送对象类型</param>
/// <param name="parameter">发送内容</param>
/// <param name="currentPage">是否只发送给当前页面</param>
public int Notifywidget(string Instanceid, InvokeType type, RpcRequest
parameter, bool currentPage = false)
{
    var widgetPackage = PackWidget(InstanceId, type, parameter, currentPage);
    return Notify(widgetPackage);
}
```

3) 示例

```
RpcRequest request = new RpcRequest();
request.method = "textchanged";
request.param = new JObject()
{
    ["text"] = edit_content.Text
};
if (comType.SelectedIndex == 0)
{
    var response = await wrapper.Invokewidget(edit_group.Text, InvokeType.Group,
request, false);
    if ((RET_CALL)response.ret == RET_CALL.Ok)
    {
        var res = response.response;
        Console.WriteLine($"{res.result}");
    }
}
else
{
    wrapper.Notifywidget(edit_group.Text, InvokeType.Group, request, false);
}
```

c++示例 (MFC)

1) 调用

```
RET_CALL Invokewidget(const char* Instanceid, InvokeType type, void* _in, bool
currentPage, void** _out, int* _out_size, int timeout = 30000);
void InvokewidgetAsync(const char *InstanceId, InvokeType type, void* _in,
bool currentPage, InvokeCallback callback, int timeout = 30000);
```

功能：业务层通过SDK向其他组件发送同步(Invoke) 或 异步(InvokeAsync) INVK 消息，并得到其他组件处理 INVK 消息后返回给业务层的结果

返回结果：见 RET_CALL 枚举说明

参数说明：

InstanceId -- 指定的组件实例名

InvokeType -- 全局发送或指定组

_in -- 业务层需要通过SDK发送给组件的消息体 (业务数据)

currentPage -- 是否只给统一页面组件发送

_out -- 服务端处理 INVK 消息后返回给业务层的结果 (业务数据)

_out_size -- _out 长度 (主要在 字符串协议 时使用, 结构体协议时为0)

timeout -- 设定的超时时间 (单位: 毫秒, 默认值: 30000)

callback-- 回调函数 (见 InvokeCallback, 用以处理返回数据)

2) 通知

```
RET_CALL Notifywidget(const char* Instanceid, InvokeType type, void* _in, bool currentPage)
```

功能：业务层通过SDK向管道服务端发送 NOTF 通知消息，用于普通消息发送，且服务端业务层无返回业务数据场景

返回结果：见 RET_CALL 枚举说明

参数说明：

InstanceId -- 指定的组件实例名

InvokeType -- 全局发送或指定组

_in-- 业务层需要通过SDK发送给组件的消息体 (业务数据)

currentPage -- 是否只给统一页面组件发送

3) 示例

```
std::string strContent = std::string(CT2A(vecString[0]));
std::string strGroup = std::string(CT2A(vecString[1]));
std::string strType = std::string(CT2A(vecString[2]));
int nInvokeType = std::string(CT2A(vecString[3])) == "1" ? 1 : 2;
RpcRequest request;

request.method = "textchanged";
request.param["text"] = Json::Value(strContent);

//请求
if (strType == "0")
{
    int outsize = 0;
    RpcResponse* out = new RpcResponse();
    RET_CALL ret = invokewidgetFunc(strGroup.c_str(), (InvokeType)nInvokeType,
&request, false, &out, &outsize, interval);
    if (ret == RET_CALL::Ok)
    {
        int code = out->code;
        std::string id = out->id;
        Json::FastWriter writer;
        std::string strresult = writer.write(out->result);
        CString strResult;
```

```
    strResult.Format(L"返回结果 code:%d, id:%s, result:%s", code,
CString(id.c_str()), cstring(strresult.c_str()));
}
else
{
    // undo
}
//通知
else
{
    notifyWidgetFunc(strGroup.c_str(), (InvokeType)nInvokeType, &request,
false);
}
```